Vol. III, Part III | Quarterly | JULY, 1908.

THE AGRICULTURAL JOURNAL OF INDIA.

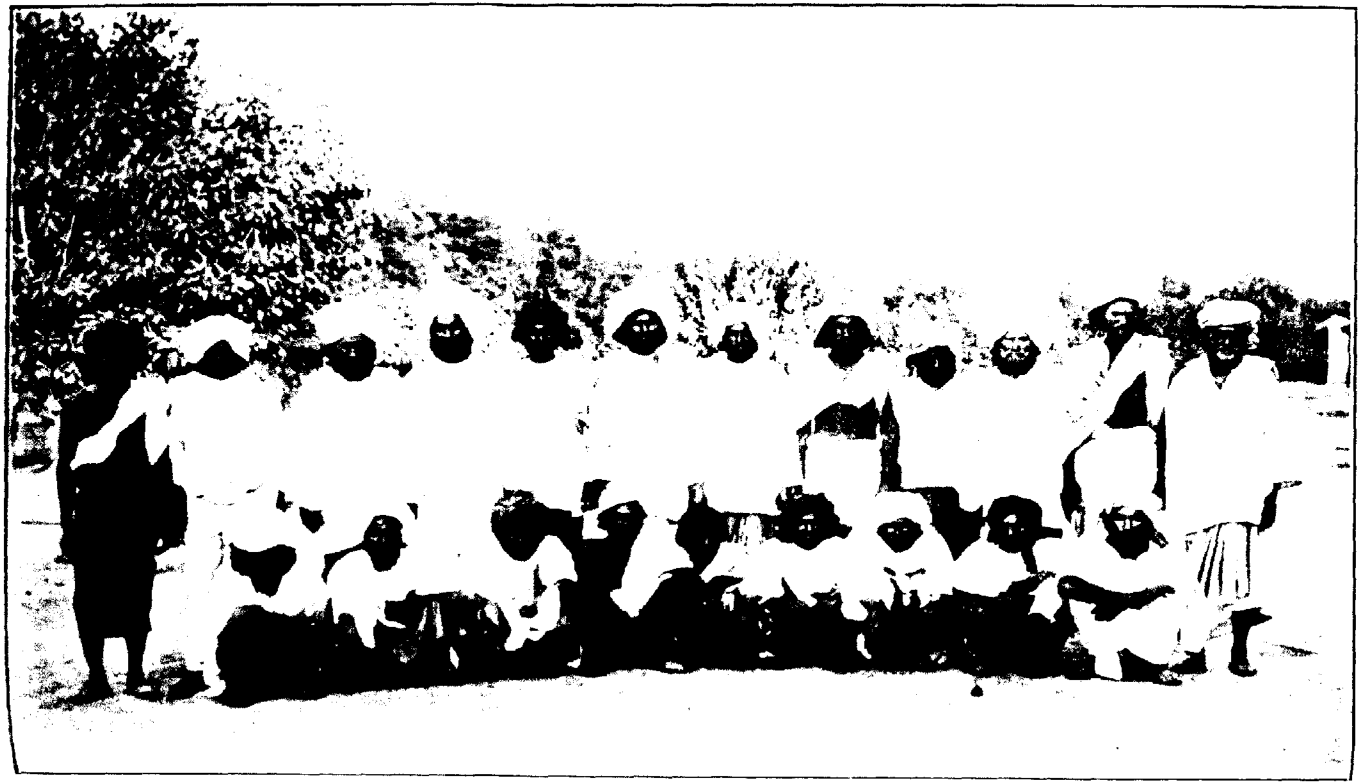
AGRICULTURAL RESEARCH INSTITUTE, PUSA.

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA
BY
THACKER, SPINK & CO., CALCUTTA
W. THACKER & CO., 2, Creed Lane, LONDON

CALCUTTA
PRINTED BY THACKER, SPINK AND CO.

CONTENTS.

PLATE XXVIII



THE CHENAB CANAL COLONY.

By G. F. de MONTMORENCY, C.S.,

Deputy Commissioner, Lyallpore.

Those anxious for information as to the origin and development of the present Chenab colony can find ample information in official volumes such as the Annual Chenab Colony Colonization Reports, the Annual Report of the Public Works Deptt., Irrigation Branch, and the Chenab Colony Gazetteer. In the present article it is not intended to tell the story of the formation of the permanent weir in the Chenab river, of the gradual allotment of nearly 1,900,000 acres of state desert lands to colonists, or of the formation of new railways and towns. It will be sufficient to dwell briefly on the material on which the colonist had to expend his labour and the class of colonist which was employed for the task of reclamation of the desert. Having disposed of these preliminaries, we can come to interesting points in the present methods of cultivation and crops of the Chenab canal colony.

2. *The Sandal Bar* from which the Chenab colony was framed, consisted of a vast rolling plain or upland lying between the Chenab and Ravi riverains. It was situated in the districts of Gujranwala, Lahore, Jhang, Montgomery and Multan. Its characteristic was its extreme flatness, with a gentle slope from the north-east to the south-west. At its highest point it is 679 feet above sea level and at its lowest 489 feet. The surface of the plain was almost entirely unbroken. At Sangla there is a group of rock hills, an outlying isolated spur of the Aravalli range, and there are two old river beds of unknown antiquity which run through the Bar for many miles. On the borders of these, some old mounds with broken potsherds and bricks testified

to some past period of inhabitation and civilization. These were, however, the only accidents which relieved the intense monotony of the flatness of the plain. The tract was one of intense heat. In the interior of the Bar the rainfall in pre-colony days was seldom more than 4 inches and often much less. In the centre of the Bar the water level beneath the surface was 104 feet. The Botany of the Bar was not of a quality or variety which much relieved the intensity of the desert. The Bar was covered chiefly with three kinds of trees, growing mostly in clumps—the *Prosopis spicigera*, the *Salvadora oleoides* and the *Capparis aphylla*, locally called the Jhand, the Van and the Karil. An occasional Ber (*Zizyphus jujuba*) or Ukan (*Tamarix articulata*) relieved the sameness of the scene. Some variety was given by an occasional low bush of Malha (*Zizyphus nummularia*) or Phog (*Calligonum polygonoides*). (Plate XXVII.) The jungle scrub varied in density towards the Ravi, and was in places too thick to force a horse through. In the southern part of the Bar the desolation and monotony increased; the sandy loamy soil with its occasional patches of clay and ample, if monotonous, scrub gave way to pure sand and sandhills devoid of bushes and trees, and ornamented only with a few grey Salsolaceous plants, such as the *Haloxylon recurvum* and the *Suaeda nudiflora*. Trees here were so rare as to be known by distinctive local names and to be landmarks for miles in the desert. The Bar was the play ground of the severest dust storms, rivalling those of the Rajputana desert. A dense dust haze often hung over the Bar for days together. Every tree and bush in the Bar with its stunted growth and gnarled, knotted limbs showed the fight which any living thing had to wage in that desert with a merciless sky. Small wonder that to the inhabitants of the rest of the Punjab, the Bar with its pathless, waterless expanse was a *terra incognita* of which everyone stood in dread. The Bar had, however, its kindlier moods and its own folk. The loam had here and there depressions with pockets of clay into which the water of the surrounding expanse would flow after scanty rains. These depressions held water for many months together. The soil of the Bar was

of such excellent quality and the accumulations of decayed leaves of the jungle scrub so vivifying that it needed but a slight shower of rain to restore to verdure the parched roots of the grasses with which the tract abounded. One shower and the Bar was transferred into a rolling plain of grasses—a thick mat of *Eleusine aegyptiaca, Sporobolus dicotalis, Pennisetum cenchroides, Andropogon annulatus* locally called Chimbar, Kheo and Dhaman grass, spread itself out. Gathered round these ponds, the Bar nomad tribes used to pasture their cattle on these grasses, and in years of any rainfall the Bar was a paradise for those who had flocks and herds. Living almost entirely on milk and wild berries, they reared fine cattle and lived on the profits and sale of young stock, clarified butter, hides and horns. Years of great scarcity would drive them to the riverains; but the true nomad grazier lived in the Bar all the year round. After a bad season he replenished his flock by liberal thefts from surrounding districts. Against this expert tracker and thief, living in a patriarchally governed tribe in the middle of the desert, those who lost cattle had no remedy and no hope. No young "jungli", as the Bar nomads were called, could wear a puggaree till he had stolen some cattle successfully. The boy was brought up with cattle theft as his only career. If he delayed his first effort, his mother was ready to rebuke him with the jungli proverb *Machhi sande pongre unde taread* (Fishes learn to swim as soon as they are hatched). Such was the Bar, a scene of extreme desolation and monotony. Those, however, who knew it in its pristine condition and know it now as the most successful agricultural paradise in the Punjab, must experience a pang of regret at the passing of a desert of peculiar natural fascination and the sudden transition from the life of the book of Genesis to the vulgar modernity of successful agricultural exploitation.

It was, however, the very monotony of the Bar plain, which made for its future success as a Canal colony. The level plain enabled the Irrigation Department to convey branches and major and minor distributaries without obstacle over an area which on the completion of the scheme will measure 6,073 square miles.

The greater portion of the Bar was *maira* soil or a sandy loam, especially easy of tillage and adapted to canal irrigation. The only poor soils which existed in the Bar were the *Kalarathi* or salt-impregnated and the *Retli* or sandy soil, both of which in the hands of good colonists improved greatly under irrigation. The flatness of the surface enabled the surveyist to lay out the whole of the Bar in squares of 1,100 feet square (about 28 acres), each of which was sub-divided into 25 sub squares, each 220 feet by 220 feet (just over one acre). A country laid out like a chess board, one of the dreams of "Alice through the looking glass," became a fact instead of a freak of the imagination. These squares formed the basis of the system on which the allotment of land was made. The sub-squares each became a separate field for cultivation and irrigational purposes. Every cultivator who received a full square would map out his agricultural programme for the year and divide up his land to tenants in details of sub squares and would be entitled to water to mature a fixed number of sub squares per square.

3. *The Colonists.* The Bar nomads scattered about the Bar were the only inhabitants. At a rough computation they numbered 50,000 at the start of irrigation in 1892. (Plate XXVIII.) At the special census of the Chenab colony held in 1906, the population of the tract which had been the Sandal Bar numbered 8,[illegible] souls. A few villages in the Bar were sold by public auction, but practically the whole of the land was given out to picked colonists. These colonists were of four kinds:

(a) Capitalists with more than five squares of land each.
(b) Yeomen with three to five squares of land each.
(c) Peasant colonists with ½, 1 or 2 squares of [illegible] each.
(d) Service grantees who held grants for the upkeep of camels or for breeding mules for transport purposes.

The capitalists were wealthy men or men who had rendered distinguished services to Government. The yeomen were usually men belonging to families of the more substantial squire or country gentleman class in the old districts. The

peasants were men picked from the ranks of the cultivators themselves in the more congested parts of the Punjab. They included in their ranks the nomad graziers of the Bar who had been dispossessed of their grazing grounds. The peasant colonists form the great bulk of the settlers and some account of their selection may be interesting. This can hardly be better described than in the words in which Mr Grant, Settlement Officer of Amritsar, gave a description of his selections: "I used to find it convenient to halt a day at the village and the evening before to call up the headmen of the village to explain to them the terms on which land would be given. They were at the same time warned that any deceit or personation would be punished by my refusing to give any land to that village, and moving on to some other. They were told that they would be required to expose any deceit that might be attempted, and to name the men who were embarrassed by debt, and the bad characters. If, afterwards, it was found they failed to expose such, the whole list was liable to be cancelled. Then, they were sent to talk it over, until the next day, when all would-be settlers came up in a body. These I would first separate into *pattis*, and make the men of each *patti* sit in a long row, the fathers next their sons, and brothers next one another. Walking down the row, I could then easily see the men who were physically unsuitable. Many old dotards and mere boys would be brought up in the hope of thus securing an extra square for the family, though they had no intention of going and would do no good if they did. His colour would often betray the habitual opium-eater, and his general appearance (more specially his hands) the *shaukin* and the *jawan* who had been in the army or in Burma, and who, cutting his name after a few years spent with a regiment, had come home to the village, but had never done a hand's turn of honest work behind the plough. Such men would never do any good in the Bar. A show of hands is a simple method for discovering the real workers among the community. Next, if any one family was represented by too many members, one or two of these would be weeded out amid loud protests. Sometimes, the three

generations would come forward headed by a hoary old grandfather, and try to secure six or seven squares between them. It was plain that they would not all go, and even if they did that their going would deprive some other family of relief, so they had to be thinned out. Then, with the patwari and the munshi at my elbow, and attended by the lambardar of the *patti*, I would go down the line and take down the names and the area of each man's share, his age, parentage, and *got*. This process would expose those who already had sufficient holdings or who had mortgaged a considerable share of their land, and these, too, were weeded out. The residue would be put down for a square each, with perhaps an extra square for the man who, by common consent, was named as the leading man of the *patti*, the bell-wether, whose lead all would follow. Thus, the original crowd of applicants would be reduced to a band of men all connected by common descent, all physically fit to take up a life in a new country under considerable difficulties, all hard up for land, but with sufficient resources to start them."*

The result of the selection was a great company of people with everything which makes for agricultural success. The capitalists and yeomen were drawn from all quarters. They had most of them seen the world, were above the average in intelligence, and had the leisure, money and acres to try agricultural experiments, new methods and new crops. The peasant colonists who received the bulk of the land had every kind of agricultural tradition and experience. There were the market gardeners of Amritsar and Jullundur. There were the sturdy Jat Sikhs of the Ferozepore and Ludhiana uplands who had grown rain crops all their lives. There were the enervated and careless cultivators of the riverains used to raising crops by hasty ploughings and sowings on rich alluvial deposits. There were the submontane cultivators of Hoshiarpur and Gurdaspur used to heavy rainfall and intensive agriculture in a congested country. There were

* Page 24, Colony Manual.

PLATE XXIX

Reaping Wheat, Lyallpur.

Amritsar and Lahore Jats with 13 or 14 years of experience of canal irrigation and cultivation on the Bari Doab Canal behind them. Lastly, there were the Bar nomads who had never held a plough in their hands or reaped an acre in their lives. There was plenty of variety in the elements. The jungli nomads had the whole lesson to learn, while the cultivators of various Punjab districts, who for years had known nothing but their own kinds of crops, their own agricultural implements and their own systems of tillage, could step into the next *chak* or colony village and see how their fellow farmers living at a distance of half the province away pursued the cult of Ceres.

4. *Crops and cultivation.* The percentages of the chief classes of crops vary every year according to seasons and other special reasons, but roughly the chief percentages are

Wheat	47	per cent.
Cotton	10	„
Toria	8	„
Maize	6	„
Millet	5	„
Sugar-cane	2	„

The remaining area is taken up with rabi and kharif fodders and miscellaneous garden, fibre, dye, and spice staples. The colonists brought with them two types of ploughs, the *Manna* or slant handed plough of the Manjha part of the Punjab, and the *hal* or straight handed plough of the Malwa tract. To this they soon added various kinds of iron ploughs from the "Kaisar-i-Hind" down to the latest American cold steel light plough. In recent years at the Agricultural show a special new class has had to be started for ploughing competitions with iron ploughs.

Difficulties of labour and a heavy wheat crop have gradually taught the colony farmer to look for a more economical method of cutting down his wheat than the day labourer with his sickle. Manual delivery reaping machines of light draft have been introduced by various wealthy grantees, and it is anticipated that in a few years the village reaping machines jointly owned by an agricultural bank or a village of peasant grantees will become a regular institution. (Plate XXIX.)

Machines for making ridges, maize shellers and huskers and winnowing machines have also engaged the attention of the colonists. Any firm, who were ready to exploit locally a really light and serviceable threshing and winnowing machine worked by bullock power, which could produce good *Bhusa* or pulverised straw, at the same time, would speedily make a fortune.

The stacking of bhusa is an interesting exposition of variety of method. The Sialkot grantee keeps his bhusa in a low heap which he plasters on the outside with mud. The grantees from the Amritsar part of the Punjab construct an elaborate thatched rick in the English fashion. The grantees who favoured the first method are gradually becoming converted to the second method as it wastes less of the surface bhusa and more effectually preserves the bhusa from attacks of white ants and rats. The first method has only one point left in its favour, that it is well nigh impossible for an enemy to set fire to the bhusa thus stored.

Wheat is the favourite colony crop (Plate XXX.) There are five European exporting firms in Lyallpur who spend their whole time in buying and exporting colony wheat. A vast agglomeration of grain at a colony station or colony market in the wheat season after the harvest is a sight to see. There are a number of Lyallpur wheats which have been introduced by various colonists. The most popular of all is the *Lal Kasauwali Chitti*, a beardless wheat with a red ear and white grain. This has all the virtues: it commands a good market price, succeeds in most seasons, does not require too much water, has a strong straw and does not shell too quickly on maturity. It keeps well and is comparatively safe from weevils. Originally unknown to many colonists and in general use only by the colonists from the Central Punjab, it has now become the chief wheat for general growth and sale. Australian wheat No. 27, introduced by the Agricultural Department, is also growing in popularity. For personal use the colonists each grow a little *Gona* or a little *Vadhanak* wheat. The former is a beardless wheat with weak straw. It is much preyed on by birds and falls down if the winds are strong at the time of changing colour. It also shells rapidly on maturity. *Vadhanak*

A. J. I.

WHEAT ON THE LYALLPUR FARM.

is a heavy, tall wheat. It requires more water than any class of wheat in the colony and is much damaged by its weight if there are rains or winds at harvest time. The jungli and the riverain grantee thought one or two ploughings sufficient for wheat sowing. They are now, however, imitating their more experienced brethren and seldom plough land for wheat less than five times before sowing. Crop experiments in the colony show that the outturn of wheat for the past ten years has kept a very steady average. The more careful grantees sow with a drill, others drop seed behind the plough in a furrow and the most indifferent sow broad cast. But even the broad casted crop is generally sown very evenly and the seed rate required for a full crop is much less than in Europe. The drill method of sowing is at present gaining ground as the best.

Cotton was an extraordinary crop on the virgin soil of the Bar when it first came under irrigation. On quite new land, with hardly any preparation, cotton in the colony used to produce 10 to 15 maunds to the acre commonly. After the first few years, however, the produce sunk down to 4 to 5 maunds per acre, an average which it maintains. Colonists brought with them several kinds of short stapled cotton, and owing to the fine profits which they made from the crop, they were not slow in experimenting with new kinds. The best of the local kinds have proved to be the Hissar cotton and the red-flowered Multan cotton. Grantees select seed of these two cottons, and after a few harvests return to the parent districts for their seed to avoid the deterioration. Khaki coloured cotton, Spence's cotton, American cotton, hybrid American and Egyptian and Assam cottons have been tried. The Assam cotton (the Garo hill variety) is doing well and seems similar in nature and requirements to the Hissar cotton on which it is an improvement. Egyptian cottons have been a failure. The bolls form too late and their complete expansion is checked by early frosts. American cotton has paid some of its devotees, but is undoubtedly more delicate than native varieties. Some colonists are persevering with Spence's tree cotton, but it has brought no lint to their mill as yet, and is alleged

to act through the winter months as a hot-case for the preservation of all the pests to which cotton is heir and from which they issue as from Pandora's box in the spring when the new-sown cottons are coming up. Ridge cultivation is being tried. The colonist has already discovered that light plough hoeing between the rows of plants in *Sawan* (July), which has somewhat the effect of ridging, is worth three or four hand hoeings. Mr. Lefroy's boxes of parasitised bollworm are already a popular remedy against the depredations of the bollworm.

Toria (*Brassica napus*) is a curiously popular crop. The vast majority of grantees in their old homes sowed Sarshaf (*Brassica campestris*) and Taramira (*Eruca sativa*) only and had never heard of this kind of oilseed. On arriving here, they found their fellow colonists of one or two districts sowing Toria and were not slow to appreciate its merits. Its popularity is easily explicable; it is put down in September; it only occupies the land for 3½ months. It requires no attention after sowing; it takes very little water, and that mostly at a time when wheat sowings have not commenced. It is reaped when wheat sowings are finished and the rush of cotton picking is at an end. It is readily bought at good prices for export to Europe, where it is turned into "fine Lucca oil." Some seasons the cultivator is repaid by 12 maunds to the acre, for which he can get Rs. per maund. It is liable to attacks of green fly and to be dried up by hot winds. Some grantees have tried spraying for the green fly when it first makes its appearance with success.

Maize and millets grown in the kharif season are the ... food-grain crops of the people. They freely enter into rotation with wheat, oilseeds and cotton. Their cultivation serves ... advantage to distribute the labour of agriculture more evenly throughout the year. The extending cultivation of sugarcane ... many holdings of small individual areas is a marked sign of ... agricultural progress. Iron roller sugar mills are in common ... and a good deal of capital per acre is invested in this crop.

The miscellaneous crops are interesting. The Arains ... *Kambohs* who are the best cultivators amongst the colonists

A. J. I.

WORK CATTLE IN THE LYALLPUR FARM.

habitually grow one or two sub-squares of potatoes and roses. They have had many imitators in growing potatoes, but no one else has as yet followed in their wake in growing roses for *atar* of rose manufacture. Other grantees are experimenting with jute and linseed grown for fibre. The retting difficulty has yet to be overcome, though, as far as produce goes, they have nothing to regret in their efforts. One grantee has been most successful in the cultivation of turmeric on a large scale; this has been previously popularly supposed to be only successful as a submontane crop in the Punjab. *Sardas* (or the Kabuli melon) have been grown by a number of colonists with success when the Peshawar colonists had once shown the way. The Amritsar and Jullundur colonists introduced lucern as a common fodder crop, and now, even in the squares of the Bar nomads, patches of this useful fodder and of *Senji* may be seen. Turnips are extensively and successfully grown as cattle food. The Chenab colonist always has his eye open for something new, whether it be a staple, an agricultural implement or a new method. An amusing incident illustrating this occurred recently. One of the most successful of the Mohamedan immigrant colonists decided to give up his worldly possessions to his son and to go on a pilgrimage to Mecca and return to live a life of spiritual introspection. His estates knew him no more for a year. At the end of the period he returned somewhat austere of appearance and reserved in conversation. A little less than a week after his return, however, he made it known that the interest of the pilgrimage had not entirely subjugated the Chenab colonist's desire for some new thing in agriculture. He had brought from the sacred place 20 different kinds of Arabian dates, one tree cotton and six kinds of Sinaitic vegetables. He has put them down and they are nearly all doing well. Many orchards have been started in the colony and orange growing promises very well. It is a curious fact that the mango is an utter failure in the colony.

The Chenab colonist has the acres and the opportunities afforded by perennial irrigation of perfecting the kind of staples

which he adopts and the method and implements for their improvement. As a body, they include some of the most experienced and skilful farmers of the Punjab. The fact that in the keen competition at the agricultural shows at Lyallpur the Bar nomad has been able to wrest the first prizes for cotton wheat and maize from hereditary experts, is a proof that even the most ignorant of the body of the colonists is determined to keep his eyes open and see what the best methods and seed selection can do for him. This tends to show that the Chenab colony will not only be known in its young days as a vast field for the production of cereals, cottons and oilseeds, but that skill and science will come to aid nature when the virgin soil begins to lose the first bloom of its virtues and that the tale of productiveness and prosperity will suffer no diminution.

PLATE XXXII

A. J. I. EIGHT YEARS' GROWTH OF TREES IN LYALLPUR.

THE FOURTH ANNUAL MEETING OF THE BOARD OF AGRICULTURE.

By E. J. BUTLER, M.B., F.L.S.,

Secretary to the Board.

The fourth meeting of the Board of Agriculture was held at Pusa from the 17th to the 22nd February 1908, under the presidency of Mr. J. Mollison, Inspector-General of Agriculture in India. It was attended by fifty-one members and seven visitors, an increase over even the large attendance of last year. These numbers were made up of the members of the Imperial Department of Agriculture; the Directors of Agriculture of each province except Bombay and several members of the expert agricultural staff of each; representatives of three Native States' Departments (Mysore, Baroda and Kashmir); the Director-General of Commercial Intelligence (Mr. Noel Paton); the Director of the Botanical Survey (Capt. Gage); the Reporter on Economic Products (Mr. Burkill); and the Scientific Officer to the Indian Tea Association (Mr. Hutchinson).

The subjects for discussion were varied. Besides a consideration of the programmes of the different Agricultural Departments, they included practical questions such as the best means of bringing the work of the Departments home to cultivators, the extension of fibre cultivation in India and poultry breeding; educational questions such as the best course of studies at Pusa and at Provincial Agricultural Colleges; and administrative matters such as the constitution of the Board of Agriculture, the form of its Report, and the staff required in certain sections of Provincial Departments, with the rates of pay necessary to secure good men for the upper subordinate posts.

In the programme of the Imperial Department of Agriculture it was pointed out that the scientific staff of the Pusa Institute will be for the first time complete and will consist of fourteen European officers, with a full complement of Indian assistants. The Institute laboratories will be finished and occupied this year, affording much needed relief to the staff, who have been working up to date in ill equipped temporary buildings. The farm is now practically all under cultivation or pasture, and it has become possible to commence permanent field experiments on land whose capacities are fairly well known. Three considerable series of manurial, rotation and pasture experiments were approved by the Board and have been commenced.

Besides these permanent experiments, which are regarded as being of the first importance, the work of the Agricultural section at Pusa proposed for the current year includes experiments with important crops, such as sugar-cane, flax and other fibre crops, tobacco, wheat, rice, maize, opium and castor, and cattle, sheep and poultry breeding.

In the Chemical section the chief subjects under investigation are the available plant food in soils; the nature and amount of substances which are removed by drainage; the factors controlling the movements of soil water; the amount of water required by various crops; and chemical investigation connected with the permanent field experiments at Pusa.

In Mycology the study of a number of crop diseases will be continued and new ones taken up. As this section, in common with that of Entomology, is intended to deal with work in all parts of India (there being no expert mycologists or entomologists on the staffs of Provincial Departments), a considerable amount of time is taken up with tours for the investigation of crop disease. The preparation of a text book on Indian Agricultural Mycology is in hand.

In Entomology, besides continuing the work of studying and advising on crop pests, the experimental cultivation of lac and of eri silk will be continued, and other wild silks taken

up. Other enquiries include the investigation of insecticides non-poisonous to cattle, the study of insect-eating birds and methods of checking pests of stored produce. Tours to investigate local pests or to deal with outbreaks of injurious insects will be undertaken. The second Entomologist will be engaged in the study of biting flies and of dipterous pests of crops. It is hoped to bring out a book on Indian insects during the year.

In Economic Botany, work on plant breeding and plant improvement will be continued with wheat, tobacco, cotton and barley, as well as other important rabi and kharif crops. A monograph on Indian wheat will be completed. The permanent experiments on the culture of Indian fruits will be continued, and also the collection and investigation of fibre-yielding plants. Other work includes the study of Cassava as a famine food-stuff (with the Imperial Agricultural Chemist), and the economic importance of the male plant in *ganja* cultivation.

In Provincial Departments the main lines of work in progress were referred to briefly in the account of the Third Meeting of the Board of Agriculture published in this Journal last year.* Nearly all are adding to their existing experimental farms or getting those recently taken up under cultivation. Several of the new stations are intended for special work, such as those at Partabgarh in the United Provinces for sugar-cane, at Daulatpur in Sind for alkali reclamation, at Chaibassa in Bengal for Tassar silk, and at Burirhat in Eastern Bengal for tobacco. Most of the older farms are engaged in more general work, as described in the review of last year's meeting, and an account of their work, and of the very varied activities of Provincial Departments, would take us far beyond the limits of the present note.

One of the chief functions of the Board is the detailed examination of these programmes with a view to suggesting improvements from the combined experience of agricultural officers in different Provinces, to prevent overlapping and to secure co-ordination where this is necessary. It was felt that

* *Agricultural Journal of India*, Vol. II, p. 224, July, 1907.

this function is not easily fulfilled by the full Board, and a recommendation was made, which will probably be followed in at least the alternate years when the meetings are held at Pusa, that the programmes should be submitted to expert sub-committees before being presented to the Board.

The constitution of the Board itself came under discussion in response to a reference from the Government of India. The number of members has grown year by year until it has reached unwieldy proportions. It was recommended that the number be curtailed to 38, made up of 11 Imperial and 27 Provincial and non-official members, six of whom should be nominated each year by the President, and four elected by the provincial expert staff. In addition, it is hoped that, in alternate years, when the Board meets at Pusa, all members of the Agricultural Departments in India (including Native States with such departments) will attend, where possible, as visitors, though not as official members.

The improvement of Indian poultry has been consistently advocated for years by Mr H. Abbott, Editor of the "Indian Fowl Fanciers and Farmers Journal." Largely as a result of his efforts, the subject was included amongst those set down for discussion at the recent meeting, and he was invited to attend. Some remarkable figures were provided of the development of poultry farming in the United States in recent years. By the census of 1900 the number of birds on the farms from which returns were secured was over 250,000,000, and the year's produce in birds and eggs amounted in value to more than £56,000,000, probably exceeding any single item of the farm produce of the United States. The Indian fowl is notoriously degenerate, and the supply besides is by no means equal to the demand, with a resulting steady rise in price. To improve the industry Mr Abbott holds that Government assistance, both in advice and in provision of improved breeds, should be given to native professional poultry breeders. In addition, a strong effort should be made to extend poultry breeding through all useful agencies in India, such as agricultural

experiment stations, grass farms, missions, European planters, Eurasians and well-to-do Parsees and Mohamedans. While endorsing much of what Mr. Abbott said, the Board considered that the results of the preliminary work now being carried on at Pusa should be awaited before any large attempt to extend the industry through Government agency was entered on. Should these experiments show that the breeding of improved poultry gives promise of becoming a remunerative industry, the Board recommended that the work should be extended through the above-mentioned agencies, and indicated generally the varieties likely to prove most suitable for breeding purposes, and some of the important points requiring attention in the care of poultry in India.

The effect of the extended cultivation in India of fibre plants other than cotton and jute on the material prosperity of the country and the best lines for future experimental work in this direction were discussed by a sub-committee. Their report indicated that the time allotted for its consideration was inadequate for so large a matter. It was decided to collect whatever information was available in each Province, and the President, together with the members of the sub-committee, were asked to arrange for the publication of a consolidated report in pamphlet form.

As the educational side of the work of Agricultural Departments in India will soon be fully organised, and there will shortly be available seven Agricultural Colleges in the Provinces, besides the college for higher instruction at Pusa, the courses of instruction to be provided at these colleges were again considered. In 1906 the Board provided a draft syllabus for Agricultural Colleges. This was now revised in certain details in the light of the experience gained by officers of the Department during the intervening period, and arrangements made to print it separately for distribution to those concerned. It is intended to serve as a basis on which Provincial Colleges will be able to arrange their courses of instruction, but it was recognised that a moderate amount of expansion or reduction may be necessary in individual cases to suit local requirements.

The greater part of the discussion ranged about the degr[illegible] to which practical training might precede theoretical instructi[illegible] On the one hand, it was held that since the majority of t[illegible] students will be deficient in regard to a general education suffi[illegible] cient to enable them to understand readily the principles of goo[illegible] agricultural practice, it should be recognised that the courses w[illegible] fall into two groups :—(1) subjects taught for their education[illegible] value ; (2) special subjects directly connected with agricultu[illegible] Since agriculture may be regarded as an art based on sever[illegible] sciences, the subjects under the 1st group are taken to be t[illegible] sciences on which the art of agriculture is founded ; and it is c[illegible] tended that these subjects should be taught in such a way t[illegible] the main object of a sound education may be achieved. These s[illegible] jects are Chemistry, Physics, Botany, Zoology, and Mathemat[illegible] It was held by several members that no sound teaching ca[illegible] given in the second class of subjects until at least a good bas[illegible] laid in the first. Hence, in the first year only these su[illegible] should be taught, and in the second year special agricult[illegible] training may be commenced.

Opposed to this was the opinion of the majority of the B[illegible] that practical training in the field should be undertaken at [illegible] very start. The arguments in favour of this view were [illegible] entirely of a practical nature, with particular regard [illegible] character of the students who would attend Indian A[illegible] tural Colleges. Many of these are disinclined by upbringi[illegible] tradition to themselves actually handle field implements. T[illegible] are amongst the better class students whom it is hoped to [illegible] for training to fit them for managing their own estates or to [illegible] managers of other estates or assistants in Agricultural D[illegible] ments. It is recognised by all that sound agricultural [illegible] is impossible, unless the actual processes of agriculture ar[illegible] out by the individual student for himself ; the introdu[illegible] practical field work at the start impresses this on the [illegible] mind and serves to weed out those who will not, for th[illegible] profit by their training. A further reason for commenci[illegible] prac- tical work at the earliest opportunity is the leaning of t[illegible] Indi[illegible]

mind towards the abstract rather than the concrete; it is feared that theoretical instruction, too exclusively followed at the beginning, may deflect the attention from the end of the training, which is to improve agricultural practice, and may lead to a neglect of the art in the study of the science of agriculture.

With regard to the class of instruction to be provided at Pusa, it is recommended that this should consist of post-graduate courses for students who have already passed through a Provincial Agricultural College, and for other selected students who, by reason of their education in science, are likely to derive real value from the advanced courses. These courses should, it is suggested, be provided for the following: (1) students intended to become assistants to provincial experts in Agriculture, Agricultural Chemistry, and in particular Economic Botany, Mycology and Entomology; (2) students sent for special purposes. Courses of instruction on these lines will be prepared at Pusa and submitted at the next meeting of the Board for approval.

A prolonged discussion took place on the rates of pay and prospects required to attract the right class of men to the subordinate staff of Agricultural Departments. The more senior members of the Board were practically unanimous in holding that the present prospects were insufficient to attract good men. The suggested rates, however, differed in the different Provinces, though the majority held that the Provincial Executive or Revenue service should serve as a standard. The Board finally suggested that the prospects for the upper subordinate staff should be made somewhat better than those of the Provincial Executive Service, in view of the fact that the service is new and specialised, but was not in a position to suggest the number of posts or particular grading required in each Province.

In connection with the recruitment and training of the requisite Indian staff, a discussion took place on the lines on which mycological and entomological work in the Provinces should be conducted. In these subjects no European specialists are engaged outside Pusa. It was recognised that the research

work should be done as far as possible at Pusa, and that Provincial work in Mycology and Entomology should be limited to the employment of a special staff (1) to give such assistance to Pusa as is required for this work and (2) for the elementary training required at Colleges. The practical field work for the prevention of pests and diseases should be undertaken by the ordinary staff of agricultural assistants. The Provincial Economic Botanist should control the mycological teaching at Provincial Colleges.

Probably the most important subject considered at the meeting was that of the best methods of bringing the work of the Departments to the notice of cultivators. In India the attempt is being made to influence the mass of the people and to bring about a gradual improvement in the industry by which the majority subsist, by working from the top downwards. It is self-evident that this attempt will succeed or fail according as the Department of Agriculture wins or fails to win the confidence of the cultivators. Could the country afford to await the spread of primary education, the work of the Department in this direction would be much lightened; this is for many reasons impossible, and the departmental officers have to face the fact that they must deal with a class whose needs are often obscure or inarticulate, who are prone to distrust official interference, who are shy of the European and whose conservatism, though sometimes exaggerated, is very often a decided bar to suggested improvements.

It has been recommended that year by year an account should be furnished to the Board of Agriculture of the efforts of the Departments in the different Provinces to reach the cultivators, and of their results. The first of these reports was drawn up at the recent meeting, and, besides being included in the Proceedings, will be separately published for general information. It deals in succession with the methods employed or suggested by the several Departments, premising that each is adapted to special conditions. The following are amongst the chief of those dealt with :—

Agricultural Associations.—The formation of local associations for agricultural improvements has been one of the most common methods of increasing interest in the work. There has been a good deal of discussion as to the value of these associations, and so far it may be said that no two Provinces have had quite similar experiences with them. This seems to have resulted chiefly from two causes: first, the personal touch maintained by the officers of the Agricultural Department and the prominent members of the Association with the cultivators; second, the extent to which the Department has as yet had real improvements of proved value available for introduction. The closest personal touch can be maintained in small associations, such as village or taluka associations, but for this a considerable number of trained officers of the Agricultural Department is required, and these are not yet available to any large extent, nor is there probably sufficient confidence in the Department to make them a success. Hence the future of the small associations is bound up with the Agricultural Colleges, and it is not until these have turned out a large number of reliable trained assistants and inspectors that any great development in this direction can be attempted.

In some Provinces, District Associations with the Collector as Chairman have been successful. As the number of these is limited, the superior officers of the Department are able to attend the meetings (held half yearly in the Central Provinces). The utility of these depends largely on the presence of a body of substantial men who are also cultivators, and on the engagement by these to carry out definite pieces of demonstrational work proved by the Department itself as likely to succeed.

It is in the provision of definite demonstrations of proved value that the second difficulty is likely to arise at the present time. So many variable factors arise in agricultural practice that progress must necessarily be slow and the departments are still very young. The introduction of a new crop or variety, or of a manurial practice, though fully tested at an experimental farm, may fail, unless the farm is exactly representative of the tract.

The cost has to be very carefully calculated or a new method may be beyond the reach of the small cultivator. Errors in the management of the demonstration are only too likely to occur. In India, agricultural change must usually follow economic change, not lead it. The extended cultivation of poor hill soils which will grow tapioca was brought about in Travancore by the rise in the price of grain, driving the poorer classes to find a substitute; without this incentive it would probably never have occurred. Similar cases could be multiplied, and it behoves the Departments to be ready to meet a demand as soon as it arises, as well as to endeavour to create a demand for new improvements.

Speaking broadly, then, the two things on which the success of Agricultural Associations in bringing about direct improvement depends, would appear to be confidence in the advisers, leading to their advice being carefully followed, and the provision only of carefully considered and tested improvements for demonstration, with arrangement for efficient management. Failure to secure these may, most likely will, result in failure of the demonstration; the confidence of the small cultivator will be shaken, and the result, with a distrustful and sceptical community, will be deplorable.

Demonstration Farms.—Similar to the demonstration work of the Agricultural Associations, only more directly under Departmental control, is the work of these farms. They have not yet been developed largely, except in the Central Provinces, but if the above-mentioned dangers are avoided, they appear to give considerable promise of success. With the associations they are bound to take a prominent place in any arrangements for the provision of good seed. This work is at present carried out by a limited number of seed farms, or by seed depôts, such as those described in this Journal, Vol. II, p. 217, in Oudh; it cannot be doubted that, in the absence of professional seedsmen comparable with those of Europe and the United States, a large development of Government work in this direction is inevitable. With such a development the utility of the demonstration farms will be multiplied.

Village Agencies. These are employed chiefly for the purpose of introducing improved implements. The agent controls the sale or hire of implements received through the Department. Repairs are arranged for by periodical visits from workmen of the Department.

Publication of Agricultural information in the Vernacular.—Several vernacular agricultural Journals are published by or under the patronage of the Departments. In the Central Provinces the monthly departmental paper has a circulation of 2,500. Better results are thought to be obtained by encouraging and contributing to privately owned vernacular agricultural Journals. For the higher English-speaking strata, the *Agricultural Journal of India* should be sufficient to meet requirements and the Provincial Departments should aim at reaching cultivators and landowners through vernacular journals. Many of the Provinces issue agricultural leaflets, which usually deal only with one definite fact, or the description of a single process which it is desirable that the ryot should know or adopt. It is too early yet to judge whether these have been generally successful, but they have been useful in certain cases. Contributions are made to the general vernacular press in certain Provinces with good results.

Agricultural Shows and Exhibitions. These have been started in nearly every Province. The exhibits are arranged by the Department, one of the members of which attends to lecture on them and arrange practical demonstrations. In some cases advantage is taken of locally arranged non-official exhibitions, and in Bombay, parties of cultivators have been taken to these and the exhibits demonstrated to them. Cattle Shows in some localities have proved a considerable success: the Department gives prizes and organises the show. Local festivals and meetings for the grant of *takavi* advances have been made use of in some cases to demonstrate new implements and other improvements.

Itinerant Assistants. In most Provinces travelling assistants have been employed for such purposes as the introduction of new varieties of seed and new implements and for advising with

regard to the treatment of special crops, as for instance, in manur-ing sugar-cane and in pointing out the dangers of over-irrigation with this crop on the Deccan Canals. In the same connection may be mentioned the travelling staff of trained well-borers maintained in the United Provinces. Their operations have been of the greatest value in inclining the people to rely on the assist-ance of the Department in agricultural matters generally.

Work directly with Cultivators.—In a few cases great improvement in local practice has been obtained by the intro-duction of cultivators from one district to another. The method is likely to be most useful where a new crop has been introduced into a district, and it is probably capable of extension in such cases.

Short courses for cultivators have been given on the Bombay farms in special matters, such as cotton seed selection. The sons of cultivators are also taken for instruction on these farms. This method is believed to be worthy of more extended trial if cultiva-tors can be induced to go to the farms for the purpose.

In all these methods the aim is to show the actual cultivator some improvement he did not know before and which is within his means. As he is not a capitalist, he cannot usually afford to gamble, but must have a certainty. His cultivation expenses are usually met from borrowed capital and the rates of interest he has to pay are exorbitant. Hence the question of agricultural improvement is closely bound up with the provision of cheap credit, and there must be intimate connection between the Agri-cultural Department and the co-operative credit organization which is being developed so extensively.

Apart from all questions of organization, the ultimate work of the Departments is to discover improvements. If any really good improvement can be presented to the Indian agriculturist he is ready to take it up. That he has not adopted many practices that to the Western eye would seem to be improvements is often because they are not suited to his own or to India's special conditions, and that would-be reformers have simply been without sufficient knowledge of these. Western ideas and Western

methods cannot be introduced off-hand into India. Much of its agricultural problems have to be worked out on the spot, and there is abundant evidence that these problems are engaging the energies of the Agricultural staff in India in a much more thorough way than ever before. Some of the many directions in which improvements may be looked for were enumerated in the account of the 3rd meeting of the Board referred to above. As these come to fruition, the organization to secure their adoption by the mass of the cultivators will be severely taxed, but I think that the outline just given will indicate that it is likely to prove equal to the demand.

A FEW POINTS REGARDING CONSERVATION OF SOIL MOISTURE.

By D. MILNE, M.A., B.SC.,

Economic Botanist, Punjab.

In India where there are large tracts of country where crops are often limited in growth by the supply of water available in the soil, any improvement in the conservation of the soil moisture would be a boon worth striving for.

One has only to travel a short distance at present to see, in the great expanse of bare land and poor crops, the sad havoc wrought by drought.

To avoid these utter failures of crops by means of careful cultural operations, the farmer can often do little, but there are cases where the alert farmer might, by skilful farming, reap a very much better crop than his more backward and careless brother.

Some farmers have told me that on their land, at present totally barren, if they could only have got their wheat to "braird," *i.e.*, germinate and spring above ground, the crop would have come to something. Whether or not any good can be done in such extreme cases is hard to say, but certainly there are lands where a study of the conservation of moisture might be well repaid

It is not my purpose in the present note to go very scientifically into the above subject, but rather to point out or remind the tillers of the soil, of a few facts, and to quicken, if possible, the interest of those whose business or hobby it is to properly investigate the matter.

First, then, it is a well-known fact that a soil on which plants are growing loses much more water by evaporation than does a bare soil.

Some plants with a root system ramifying through a fairly large area, to various depths in the soil, and possessing also a considerable extent of leaf surface for the dry winds to play over, may evaporate a very large quantity of water, indeed, in 24 hours.

I have no Indian figures at hand, but for Europe we find several.

In Pfeffer's Physiology, Vol. I, pages 250 to 251, we find recorded: "Hales found that a sunflower having a total area of leaf surface of about 9 sq. m. ($10\frac{3}{4}$ sq. yards) lost 0·85 kilogrammes (1 pint) of water during a single dry day." "Haberlandt found that oat-plants covering one hectare transpired 2,277,760 kgs. during a single vegetative period, while barley plants covering a similar area exhaled 1,236,710 kgs of water." This means that an acre of oats evaporated nearly 900 tons of water, and barley well on to 500 tons during their respective periods of growth.

Whatever accuracy these men may claim for their figures in their own conditions, my point is, that although plants may differ in the relative amounts of water transpired from them during a given time and in various conditions, it is a well-known fact that all plants do transpire a very considerable amount of water during the 24 hours.

It is evident, then, that from the point of view of the farmer cultivating lands in a droughty country, the lands should be kept clear of weeds.

Again, it is well known that on bare land which is fairly firmly consolidated right to the surface, more moisture will eventually be lost by evaporation than on land the surface of which has been well pulverised and kept stirred to the depth of a few inches.

One might very roughly explain this by saying that the water rising up the walls of the minute openings between the soil particles can, in the case of the compacted soil, rise right to the point where it can be quickly evaporated by coming directly in contact with the dry winds sweeping over the surface of the land.

As the moisture at the surface is evaporated, more is induced to take its place, and as it must come from below, we have a comparatively rapid current of water being brought upwards and lost by evaporation.

In the case of the soil of good tilth, the surface, few inches of which are stirred up loosely, the openings between the particles are too coarse to allow the moisture to rise freely in these few inches. Also in the large interspaces between these particles a considerable volume of air is trapped and forms a semi-damp more or less stationary protective cushion of air between the quickly changing dry atmosphere above, and the point to which the water is comparatively easily brought up.

Whatever the real theoretical explanation may be, however, the point of practical importance is, that a soil, the surface [illegible] inches of which is well pulverised and stirred, does conserve the moisture much better than a more compact one, and [illegible] farmers who wish to retain the moisture in any particular [illegible] of land, should not simply plough the soil and leave it in large rough lumps, and great openings between the furrows, [illegible] should pulverise and stir the surface by harrows or other suitable means.

This pulverising of the surface should be done the same day as the land is ploughed on all soils, but especially on [illegible] clays, not only because of the saving in moisture effected, [illegible] also because of the greater ease with which the lumps [illegible] broken.

Treated promptly in this way, a fine tilth may be got [illegible] and with ease even on stiff lands where no amount of work [illegible] procure a good tilth if the lumps are allowed first to get dry.

A third way of conserving moisture is often practised [illegible] various parts of the world. It is called "mulching."

Some fairly open or porous material such as refuse [illegible] inferior grass, or inferior straw, leaves, or other organic [illegible] stance, is spread in a thin layer over the surface of the [illegible] the idea being to form a layer of matter which will [illegible] considerable volume of air in the spaces between its com[illegible]

particles, and so retard the swift exchange of the dry air of the atmosphere for the more or less moist air that is in contact with the soil surface. Mulching therefore has underlying it the same idea as the stirring and pulverising of the upper few inches of the soil.

Unfortunately, mulching, though very useful, is difficult to carry out on large areas. In some parts of India, however, I believe it is a common practice for special crops, such as tea, coffee, and some market garden crops.

The implements used in tillage operations here appear to me of considerable interest in relation to conservation of soil moisture, and I think a study of these from this point of view might give some results worth having.

Take, for example, the ordinary native plough and compare it with the common English or American ploughs.

The native implement differs essentially from the other two quoted, in the fact that while the others partly or completely invert the soil, the native one stirs but does not invert it.

The difference appears to me to hold in it a question of considerable interest, for if a slight mulch causes a material reduction of the amount of water evaporated from the soil, then, may there not be a material difference in the amount of water evaporated from a soil ploughed by an English plough and one ploughed by the native implement?

In the one case the organic matter of the previous crop residue would be more or less deeply buried, and in the other practically left on the surface to act as a mulch.

With years of tilling with the native plough, and the consequent accumulation of organic matter on the soil surface, which might be expected up to a certain point, the beneficial mulching effect might also be expected.

I should like to hear of some farmer using the native and an American or English plough on two separate areas, under similar conditions, over a number of years, and noting the practical effect on his crops, and if he or some one interested would like to go further into the matter and had the necessary skill and

apparatus, a set of borings of these lands could be taken and the amounts of moisture in them ascertained and compared at intervals.

The borings might be taken at different depths; regular intervals of time; of cropped and uncropped areas; and other points may require attention

The above, however, are mere suggestions.

Besides conservation of moisture, there appears to me another good effect to be got by not inverting too thoroughly the residue of the previous crop, and that is the prevention to some extent of the formation of that extremely hard layer, often not more than a quarter inch thick, which forms on the surface of stiff soils, or even on light ones if there is a tendency to efflorescence of white salts. These salts, though present in the soil in such small quantity as not to be directly very harmful to vegetation, may, when collected at the surface by evaporation, cement the particles of the upper quarter-inch of even a light soil till it has almost the consistency of rock and completely strangles vegetation.

The formation of this hard layer may, by this practice, be modified partly by the lesser concentration of salts at the surface owing to the mulch, and partly to the greater admixture of organic matter of previous crop residues in the upper layer of the soil where the salts concentrate.

I have never seen the surface of a slightly salt soil in which there is an excess of organic matter harden as I have seen that of even an extremely light sandy one.

In the event of there being anything in this idea that the native plough tends to conserve moisture and prevent caking of the surface soil more than an American or English plough does, it does not mean, I hope, that the native plough will be left in undisturbed possession of the field.

To me the native plough appears an implement with a good deal to recommend it to the native agriculturist.

Its low initial cost; the almost impossibility of breaking it; the ease with which it can be repaired if it is broken; its comparatively wonderful effectiveness when properly handled, and

other advantages, all stand in its favour, but I think there are other implements already in the market, or which could be made, which could replace it to some extent with advantage to the farmer.

The native plough, as I have said, differs essentially from the British idea of a "plough," in that it does not turn the furrow, and appears to me to be more comparable to the implement called a "cultivator."

This suggests to me that a good strong implement of this type, having not too many "tines" or "teeth," so that the draught would not be too heavy for two bullocks, might replace it with advantage, at least in some tillage operations, and give practically the same effect as regards the inverting the soil as the native plough does.

Some of the advantages of the "cultivator" are:—Having a number of tines set in a frame at regular distances, there is less chance of patches of the land being "missed" by careless workmen.

A much greater area is covered: a point which in these days of scarcity of labour is worth considering, and they are simple enough to be worked and understood by anyone.

The repairing of these implements is, I know, a difficulty, as also their initial cost, but these difficulties will tend to lessen in time.

As more iron implements are brought into use, the blacksmith will become more common in the community, and as the calls for his services to repair such implements become more frequent, his knowledge of them will increase as well as his stock of necessaries for their repairs, and with these the present difficulty of the rayat will lessen.

The difficulty of the initial cost will diminish when it is proved that the implements are worth the money.

The "Sohaga," from its consolidating action on the upper layer of the soil, is not the best implement to put last over a piece of tilled ground not to be immediately flooded with water, and required to retain its moisture well.

Again, in relation to the economical use of the soil moisture, we have the problems of finding out the relative amount of water required by each of the common crops during a growing season, the best arrangement of crops in a rotation from this point of view, and many other questions far too numerous for me to say anything about in such a note as this.

It will be quite satisfaction enough for me if I have achieved in some measure the object with which I set out.

CASSAVA AS FAMINE FOOD.

BY F. BOOTH-TUCKER.

WHILE travelling in Travancore last January, I learned from inquiries that the high prices of rice and other staple grains had reached even this distant and comparatively isolated corner of India. Yet the people seemed unusually prosperous and well-fed.

Famine, I was told, had been unknown for the last thirty years, in the sense in which it afflicted other parts of India. Droughts there had been, and scarcities, and high prices, but the necessity for extensive relief works, or the decimation of the population by famine deaths, were things unknown to the present generation.

My informants pointed to the familiar Cassava plant, a plot of which was attached to every cottage home and the cultivation of which had now become practically universal.

Each acre could produce from five to twenty tons of the tuber, so that a small patch would supply an entire household with food and render them independent of the fluctuations of the grain market. The rains may fail and rice may be dear, but there is always an abundant supply of the drought-resisting "Marachini" to fall back upon.

We were the guests of a retired Travancore Judge, and were thus in a good position to gain the most reliable information possible. Specimens of the raw tuber were shown us, and in different forms it was included in the generous diet which our kind hosts had provided for us.

What struck me, however, most of all was the *Indianisation* of the Cassava in Travancore. To persuade Indians to take to tubers as a staple article of diet had always appeared to me an

almost hopeless task. As a mere "bonne bouche," appetiser, or addition to their vegetable curries, or as an enforced but disliked "dernier ressort" in case of actual famine, its popularity would be limited and there seemed little hope of securing for it a place amongst the staple foods of India.

Here in Travancore, however, a simple device had been adopted which, I could see at a glance, placed Cassava amongst the front rank foods of India, and gave her the entrée to all castes and classes of the people.

The roots had been boiled, cut and sun-dried for purposes of preservation. The next step was an easy one, to reduce it to powder with an ordinary rice-pounder or country hand-mill. It then made a delicious and tasty flour, very wholesome and capable of being mixed with other forms of flour.

The next inquiry was naturally in regard to prices, and here I was glad to find that it had not so far been affected by famine conditions. In ordinary seasons the price of the sun-dried product ranged in various localities from 20 to 40 seers per rupee.

Cassava land, I was told, rented as high as Rs. 25 per acre and brought in an income to the cultivator of from Rs. 100 to Rs. 150. Hence it was a profitable crop to the agriculturist, and with a wider market would become still more so.

The next difficulty was the question of transportation. It was obvious that unless the new food could be carried at a reasonable rate, it would be impossible to deliver it in the famine regions at such a price as would enable it to be of any use to the people.

Another more serious difficulty to overcome was the universal incredulity on the part of all concerned (outside Travancore itself) as to the willingness of the people to take to any kind of new food.

However, persistence and enthusiasm in a cause, regarding the ultimate success of which I entertain no shadow of doubt, has enabled us in a large measure to overcome the initial difficulties.

The leading Railway Companies have consented, at least temporarily, to admit the new intruder to the same privileges as other staple articles of the people's diet, instead of placing it on

the shelf among luxuries denied to all but the rich and well-to-do. In this we have received some assistance from the Railway Board.

In regard to the circulation of the new food, I have consulted freely with Indian grain merchants. Indeed, it has been here that I have received the largest measure of co-operation and support, the importance of which it is impossible to exaggerate.

I have felt from the first that if we could create a demand for the article on the part of those who had their fingers on the pulse of the food supplies of India, success would be assured. They would see to it that the agriculturists of India were made acquainted with the merits of Cassava, and would make suitable arrangements for a supply commensurate with the demand.

Calling personally on some of the leading merchants of the bazaar, I showed them Cassava, both in its sun-dried form and when reduced to flour. They liked the taste and appearance, experimented with a small quantity and then ordered several maunds for further trial. They then tasted it by itself and also when mixed with other kinds of flour.

So satisfactory was the result, that I have already received orders for a supply of about 1,000 maunds, and have been asked to make arrangements for a regular and steady supply of the article. In addition to this, spontaneous requests have been made by these merchants for full information as to the cultivation of Cassava and for a supply of cuttings, with the assurance that a considerable amount of land will be planted with it during the present season.

Being anxious to spread the experimental operations over as wide an area as possible, we have tried the Cassava in our Salvation Army Boarding Schools for boys and girls not only in Travancore, where it is already known and liked, but in the Deccan and the Punjab, with the result that the children have taken readily to it, and have asked for it to be made a permanent part of their bill of fare.

Arrangements have also been made for planting Cassava on our Farm Colony in Gujarat near Ahmedabad, and also at

Ahmednagar, Bareilly, and other places where we have land, with a view to exploiting it in the various neighbourhoods.

One hundred maunds of the Cassava have been ordered by the Famine Commissioner of the U. P. for experimental use at the poor houses in Gonda and Bahraich, the labour of the women being utilised to reduce it to flour by means of the ordinary *chakki*. The district officers report that there has been no difficulty in getting the people to adopt it as part of their diet.

It may, therefore, be fairly assumed that Cassava in its sun-dried and flour form has now made a successful début both as a Famine fighter and as a permanent and popular article of diet in India.

The importance of this it seems difficult to exaggerate.

1. Cassava will grow in almost any part of India, and is already to be found in districts so widely separated and differing in climate as Nepal, Darjeeling, Assam, Bengal, Madras and Travancore.

2. The root will resist drought and can be left in the ground a considerable period after maturing, without requiring to be rapidly and simultaneously harvested, and is immune from the attacks of white ants.

3. In its sun-dried form it will keep for a year and is very convenient for transportation and cannot be mixed with deleterious articles.

4. It is easily cultivated and is a very profitable crop.

5. Countries where it is well known and largely grown such as South America, East and West Africa, Madagascar, etc. while liable to droughts and scarcities, are said to be absolutely immune from the ghastly death roll and depopulation, which so frequently accompany Indian famines.

6. In its flour form the universal prejudice against the use of tubers is dealt with and overcome.

PLATE XXXIII.

[illegible] Main Valley with [illegible] Mountain.

LEAF MANURING IN SOUTH CANARA.

By M. E. COUCHMAN, I.C.S.,

Director of Agriculture, Madras.

One of the most interesting and important duties of the Agricultural Department will be to ascertain, by detailed local enquiries, what use is made by the cultivators of each tract of the sources of manure available to them. A few notes regarding the agricultural practices of the District of South Canara, in the Madras Presidency, may therefore interest some readers of the Journal.

The District is a narrow strip of land lying between the western ghauts and the sea. Originally a laterite plateau, this has been cut up into deep valleys by numerous rivers rising in the hills, fed by a rainfall of from 120 to 200 inches. The valley bottoms have been converted into rice-lands, which extend to varying distances up the sides of the hills, according to the steepness of the gradient, and the pressure of population. In the adjoining district of Malabar, where there is a larger population, many of the hills have been carved into terraced fields to the very summit (Plate XXXIII). In South Canara the slope of the hill is covered with scrub jungle, but when the top of the hill itself is reached, it is usually seen to be a bare plateau, covered with short grass during the rainy month, and almost bare in the hot weather. In many parts the surface is mere laterite rock on which nothing will grow. Rice is practically the only crop grown. The almost continuous rain which falls in June, July, August and part of September suffices to grow the first crop of rice. For the second crop, dams of brushwood and earth are thrown across most of the larger streams, and the numerous springs which flow from the steep

laterite hills are carefully trained along the sides of the valleys. Where these are insufficient, shallow pits are sunk in the corners of the fields and the water is baled from them by a picotah of peculiar construction. Instead of two men walking to and fro on the top of the lever, a number of ropes are attached to the end remote from the bucket. A hole about 6 feet deep is dug beneath this end of the picotah, with steps cut in one side. Four or five women and children hold the ends of the ropes, and when the bucket is full, they throw themselves backwards into the hole, thus pulling up the bucket. They then walk up the steps cut in the side of the pit, and so the work goes on. It has this advantage over the picotah of the East Coast, that whereas the latter requires strong and well-trained men, and there is always some danger of the men falling from the lever, the South Canara picotah renders the cheap labour of women and children available, and is perfectly safe. In some parts a third rice crop is grown, but this is almost invariably by lift irrigation throughout. The usual practice is as follows.

In April and May parts of the low lying lands are wet ploughed in the dry, and dry seed-beds prepared, the seed broadcasted and ploughed in. In many cases the "mango showers" suffice to germinate the seed. These seed beds are called "dust seed-beds," and the seedlings raised from them are considered more robust than those raised in wet seed beds. Where there is not sufficient moisture in the soil, the seed beds are irrigated from a shallow tank or well with the picotah described above. Seedlings raised in this way, with what is called "old water," *i.e.*, before the south west monsoon rains commence, though not so good as those grown in the dry beds, are preferred to those sown after the burst of the monsoon. The monsoon usually bursts about the end of the first week of June. By this time the seedlings are almost ready for transplantation. The lower lying lands are hastily prepared and transplanted soon after the middle of June, the higher lying lands being planted as soon as cattle and labour can be spared from the work on the more valuable low-lying fields.

PLATE XXXIV

PLOUGHING LANDS FOR SECOND CROP. SURROUNDING JUNGLE AVAILABLE FOR CUTTING LEAVES.

A. J. I.

Harvest of the first crop on double crop lands begins soon after 15th September. Seedlings for the second crop have in the meantime been prepared in a field left vacant for the purpose. The stubble is hastily ploughed in, manure applied, and the second crop planted in October. This is harvested about the end of January. Where a third crop is raised, this is put in soon after the harvest of the second, and harvested about the middle of May.

From this short account of the ordinary methods of cultivation, it will be clear that a severe strain is put on the fertility of the soil. The same cereal crop is raised year after year, and in some cases rice is on the ground for eleven months out of the twelve. The torrential rainfall washes most of the soluble plant foods from the soil, and land left uncultivated soon becomes incapable of growing anything but a little coarse thatching grass. The object of this paper is to describe some of the methods by which the cultivators maintain the fertility of their lands as no oil seeds are grown except a very small quantity of gingelly for domestic consumption. No cake manures are available. Neither is there any *poonac* or *neem*. The cocoa-nut cake is either exported or used as cattle food. There are no sheep and very few goats. "Penning" is, therefore, out of the question. Some fish manure can be obtained, but this is mainly used for tobacco.

The sheet anchor of the South Canara ryot is his leaf manure. As a rule, the exclusive use of 100 yards of the slope of the hill lying above his land is permitted to the ryot free of all charge (Plate XXXIV). A wall and ditch are put round this, and the jungle is strictly protected by the ryot. He does not, as a rule, cut the green branches from the trees in this land, but contents himself with sweeping up the fallen leaves. Beyond this lies the open hill side, and the plateau on the top. Outside reserved forests, anyone can cut and remove green leaves and twigs from tree growing in this area. With the heavy rainfall and equable moist, warm climate the growth of all vegetation is extremely rapid, but the incessant industry of the ryots keeps all growth down to a low coppice about 18″ high. In the more thickly populated

parts, the continuous severe cutting of green leaves and twigs has killed out all growth. In some villages the ryots combine to reserve a portion of the waste land in the same way as individuals protect the 100 yards of land immediately adjacent to their own. No green leaves are then cut, the dead leaves alone being swept up. More commonly the ryots of each village content themselves with keeping the jungle-growth on the waste lands within the boundary of their village for their exclusive use. Different methods are in vogue to secure this object. Sometimes it is declared to be dedicated to some local god or demon, and an annual ceremony performed to impress the minds of outsiders. The efficacy of such methods, however, is not what it was. The writer once asked the people of a village how they managed to keep the jungle-growth on the waste lands of their village so good as it was. "We make a *bandobast*," they said, "to prevent the people of the other villages cutting it."

"I suppose that means that if the people of other villages come to cut your leaves you collect your tenants and give them a good hiding."

The deprecating smile which followed showed that this had hit the mark. Throughout the year the spare time of the ryot and his family is fully employed in cutting green leaves from the unreserved land. The leaves are tied into a bundle as large as can be carried, and taken home. The heavy rainfall makes it absolutely necessary to provide some shelter for his cattle, and the South Canara ryot has evolved for himself a simple and effective form of loose-box which makes the best possible use of the leaf-manure. A pit is dug to a depth of about 4 feet. The other dimensions depend on how many cattle he has. A light thatched roof is built over this and the sides are fenced in with railings. At night the cattle are driven in from the field where they have been grazing all day, and as a rule tied separately to posts, grass or straw being sometimes placed in front of each. The cattle are kept in the shed till about 8 A.M. the next morning. The floor is strewn with a covering of leaves renewed every day. Where leaves are scarce, the paddy stubble

PLATE XXXV

A. J. I. COOLIES CARRYING LEAF-MANURE TO THE FIELDS FROM CATTLE SHEDS.

is pulled up by hand and used as litter. The pit will be full in about a month. The leaf manure, which has absorbed the solid and liquid excreta of the cattle, is then removed and either put in a heap or pit, or taken straight to the field where it is to be used, and stacked in a corner, if there is a growing crop already on the ground. If the ground is bare, it is placed in heaps over the field till it can be ploughed in. All the green leaves and leaf-manure from the cattle sheds *have* to be carried in head loads, the use of carts being impracticable owing to the hilly nature of the country (Plate XXXV).

It will be seen at once that this system utilizes to the full both the liquid and solid excreta of the cattle, and produces a very rich fertilizer. At the same time the leaves and sticks improve the physical condition of the soil. The system is possible, because wood is almost always available for fuel, supplemented by the leaves of the cocoanut and palmyra palm. One would, however, like to get at the impartial opinion of the cattle on the subject. Their sleeping place is neither clean nor sweet smelling.

Where labour is available, the crop is always transplanted. In some cases the seed is steeped in water for a day or two, and then mixed with well rotted leaf manure and ashes in the proportion of one basket of seed to ten of manure, and either dropped in small handfuls all over the surface of the puddled field (Plate XXXVI) or sown behind the plough, in the same way as castor, etc., are usually sown in other parts. The latter system can, of course, only be practised when the land is ploughed and sown in the dry. This is, therefore, only done for the first crop and with unsteeped seed. Other manures applied to the paddy fields are wood ashes, which are carted to long distances from the large towns, and "burnt earth," a compost of leaves and other rubbish mixed with soil and burnt. Where the ryot has not sufficient cattle to pass all his leaves through the pen, he applies them direct to the field. For this purpose green leaves are preferred. Before leaving the subject of leaf manure, one more practice must be described. Cocoanut trees which are grown in gardens are usually heavily manured

with cattle dung, etc. The trees which are scattered along the bunds of the fields as a rule receive only the following treatment. A deep circular pit about a yard deep is dug all round the trunk, and this is filled with the leaves and boughs of the *Nux vomica* tree, which is extremely common here. These are then covered up with soil. It is believed that this not only acts as a stimulant to the tree, but protects it from boring insects.

Apart from manures, the chief means by which the fertility of the wet lands is maintained, is by growing leguminous crops after paddy. In the case of the lower-lying one-crop lands, these are sown in September—October, and in the case of two crops in January—February, where the soil is sufficiently retentive of moisture. Horse-gram (*Dolichos biflorus*) is usually broadcasted in the standing paddy shortly before the paddy is cut. For green and black gram (*Phaseolus mungo*), the best cultivators plough up the stubble, apply ashes, and secure a fine tilth before sowing the pulse crop. The whole plant is removed when the grain is ripe, but so well is the beneficial effect on the soil of the leguminous rotation understood, that in some places ryots who cannot sow the pulse crop themselves will permit others the free use of their fields for this purpose. It is hoped to introduce ground-nut on the sandy soils, as an alternative to these pulses. Though some irrigation would be necessary, it would be more profitable, and at the same time the cake would afford another source of manure. "Green manuring" in the sense of growing a leguminous crop on the ground to be ploughed in at the time of transplantation is quite unknown here. As leaf manure becomes scarce, with the destruction of the jungle, it will be one of the chief problems of the Agricultural Department to see if it can be replaced to some extent by green manuring.

PLATE XXXVI

A. J. I. SOWING SPROUTED SEED, MIXED WITH DECAYED LEAF-MANURE, IN PUDDLED PADDY FIELD. (SECOND CROP).

IMPORTED INSECT PESTS.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

In almost all countries where Agriculture is of any degree of importance, measures are taken to prevent as far as possible the introduction of insect pests; in some countries these measures are stringent and the importation of living plants, for instance, is conditional on their being fumigated at the port of entry so as to minimise the danger of bringing in a harmful insect. Unquestionably many of the more virulent pests of the world have been spread from one country to another by commerce, and it is almost a law of nature that such introduced insects shall, once established, be far more destructive in new places than in their original habitat.

In this country, there are no such measures of precaution, except in the case of American cotton seed, which is fumigated at the ports of entry to ensure the destruction of the weevil, which in the Southern States works such havoc in the cotton boll; the question has often been mooted and, on general grounds, it would seem that India should follow suit and adopt precautionary measures.

It is of interest to first consider whether in the past, with a large volume of trade with other countries, with an entire absence of any restriction or precaution, any undesirable and injurious insects have been introduced; among the common pests of Indian Agriculture, are there any that are likely to have been imported by commerce, or are there natural circumstances which protect India from such invasion. Evidently such an enquiry is the preliminary to any further action, and unless we have data of

this kind, we are not in a position to form an opinion on th difficult question.

We propose here to give such facts as throw a light on th subject: in a later paper we propose to consider, first, those pes that are not now in India and that might come in, and secon the nature of the imports that would bring them in and th volume of trade that would have to be dealt with in any precau tionary measures.

It is possible to make a list of the more important pests crops in India and to tabulate them according as we know the to be indigenous or introduced, or as we believe, from all th available facts, that they are indigenous or introduced. we hav also to consider whether introduced ones have been brought by man (and so preventably introduced) or by nature. It impossible here to take each insect and give all the facts which to place each one. we select a few typical examples deal with them as an illustration of the method used in tabulat each one.

A very common and widespread insect is the sweet pot weevil (*Cylas formicarius*): its grub lives in the sweet pot in the soil; it is found constantly all over India, and has be recorded from India for more than a century. It was first descr from specimens that came from Java, India or some part of Indo-Chinese region, and for long was regarded as a rarity has since been found in Australia, the West Indies, the South States of America; in all of these places it has been found during the last forty years, and in them it is not widesprea universal, but occurs only here and there. It has the appear of an indigenous insect in India and Java, of an introduced i elsewhere; we place this among our indigenous insects.

Another instance is the notorious potato moth (*Phthor opercutella*), whose caterpillar lives both in the plant and tuber, whether in the ground or stored. In India this is known to occur in potato growing tracts in Bombay, in Be in the Central Provinces, in Madras; in some of these place potatoes have been imported from Europe for some years pa

many, the potato-growers state that the pest is of "recent" origin, naming ten or twelve years or similar periods. The pest is apparently absent in parts of Bengal, where seed potatoes are usually obtained from the Himalayas. In Europe the pest is known to occur in countries round the Mediterranean: it occurs also in Australia and in America. Its native home is in doubt, but it is undoubtedly a recent introduction to India, brought in with shipments of seed potatoes probably from Italy. This is perhaps the most decisive case of an introduced insect that can be named.

We may take as another example, the American bollworm (*Chloridea obsoleta*); in the United States this is a pest to cotton, to maize, to tomatoes, etc. It is practically world-wide in distribution; in India it attacks gram, opium, tomatoes, pulses, etc., a few wild plants, and out of hundreds of cases, only once has it been found to attack cotton. It is widespread in India, occurs abundantly and has the characters of an indigenous insect. No one can now say where this insect first started from: it is extraordinarily omnivorous; it is like the sparrow in its disregard of heat and cold; it is as likely to have originated in India as in America, and it may be classed as an insect that has, without the intervention of man, spread over almost the entire inhabited world; we can find no evidence of its being an introduced enemy, or if it is, it may have been a natural introduction before agriculture flourished in India.

Another case is of interest; the commonest butterfly in India next to the Akh butterfly (*Danais chrysippus*, Linn.), is the beautiful butterfly whose caterpillar feeds on orange, lime and lemon trees (*Papilio demoleus*). This occurs also in South Africa, and geologists tell us that there is an affinity between the fauna of India and South Africa, because they were once connected by a Continent. Is this insect indigenous to both, or did one send it to the other? It has in India all the characters of an indigenous insect, and we can find no evidence to place it in one rather than in the other table. For our present purpose we may class it as an indigenous insect, not likely, from its habits, to have been capable of introduction artificially by man.

The Death's-head Moth (*Acherontia styx*, Westw.) has a wide distribution over temperate and tropical Asia: it has in India the character of a well-established and indigenous insect, feeding not only upon cultivated but on wild plants. It is a strong flier and is extremely likely to have distributed itself naturally over the area in which it is now found: at the same time, there is no stage in which it is likely to be carried by commerce, since the chrysalis in the soil is the only long dormant stage in which food is not required. We place this as a natural introduction or an indigenous insect.

The Surface Caterpillars are a well-known form of pest in India as elsewhere; our two common species (*Agrotis ypsilon*, Roth. and *Euxoa segetis*, Schiff.) have a wide distribution outside India: the group as a whole is characteristic of temperate climates, a vast number of species living in Northern Asia and Europe: there is reason to believe that one species (*E. segetis*, Schiff.), has actually spread from the Himalayas through the hill forest areas of India and established itself at altitudes of 2,000 feet and upwards; whilst the other (*A. ypsilon*, Roth.) actually appears to migrate annually from the Himalayas to the neighbouring plains for the cold weather, the March brood returning to the hills again. These are, we think, clear cases of natural spread of a temperate climate species into a tropical climate by a process of adaptation, and we class these as natural introductions.

We may take another instance from the moths; the Castor Semilooper is one of our more virulent pests; it is common in Africa, South Eastern Asia and Australia; it is very difficult to see how such an insect could have been carried artificially to India; it has a common cultivated food plant, castor, and has a very common wild one, *Euphorbia pilulifera*; and we consider the probabilities are that it has spread naturally over these regions without the intervention of man.

The above cases illustrate the way in which it is possible to decide whether to class an insect as indigenous or introduced. By applying this method and by taking into account the

habits of the insect and its possibility of introduction, it is possible to tabulate our pests into the classes given above.

In order to give shortly the result of such an examination of our injurious insects, we may take them group by group. Of injurious grasshoppers, locusts, crickets and the like, we can class none as certainly introduced; the migratory locust (*Schistocerca peregrinum*, Oliv.), is believed to be of South American origin, but it has undoubtedly established itself in North India by purely natural means. With one exception, it is extremely difficult to see how any of these insects could be artificially introduced and we may class our ten or twenty as all indigenous; the mole cricket (*Gryllotalpa africana*) is a possible visitor, its distribution being wide, but it has the characters of an indigenous insect. Of the bees, wasps, and ants, one sawfly and two ants are injurious; but they are distinctly indigenous and, though commerce may have brought in ants that are a nuisance in our houses, no real pest has been brought in.

We come next to the beetles; confining ourselves for the moment purely to crop pests, there is no single beetle we can point to as an introduction. The extraordinary statement has been made that injurious lady bird beetles were introduced from Australia by the coffee planter sent to find an enemy of the coffee scale, but there is no foundation for this statement in fact, as the supposed introduction is an indigenous insect.

Of the butterflies and moths, we can mention the potato-moth as a certain, and the Diamond-back Moth as a possible, introduction by man; we can mention also a small number of species, such as the American Bollworm (*Chloridea obsoleta*), the army worm (*Cirphis unipuncta*), the indigo caterpillar (*Caradrina exigua*), the greasy surface caterpillar (*Agrotis ypsilon*), which are very widely distributed over the earth, but which, there is no reason to think, are other than natural introductions or indigenous insects; they owe their wide spread to their omnivorousness and their adaptability to climate, not to man, just as the Akh butterfly (*Danais chrysippus*) and the painted lady (*Vanessa cardui*) do, these being quite harmless

species. In fact, out of over eighty species, there is nothing to point to more than two species as introductions by man.

With the flies, we come to debatable ground, and the origin, for instance, of the common gourd fly (*Dacus cucurbitæ*, Coq.), may be put in India or China at will. But there is no reason to believe that any destructive fly has been introduced by the agency of man, rather that India has possibly given forth such species as the melon fly to be a scourge to other countries.

Finally, we come to the sucking insects, the bugs, Aphides and scale insects; taking the bugs apart from the Aphides and Coccides, it is impossible to fix on any species that may have been introduced; our dozen or more destructive species are indigenous. Of the Aphides (the Greenfly and Plantlice), the reverse is the case; our injurious species are world wide, either because they have been spread artificially or naturally, or because it is very difficult to find characters by which to distinguish species; our six most injurious species are of wide distribution, and it is impossible to say that it is either natural or artificial. The probabilities seem to be that they are introduced, but it is by no means certain. Of the mealy bugs and scale insects (*Coccidæ*), we have more definite data on which to decide. No one would regard the green bug of coffee (*Lecanium viride*, Gr.) as indigenous; the brown bug (*Lecanium hemisphæricum*) of coffee is probably an introduction, as may be the coffee root bug (*Dactylopius citri*) and some others; in fact, of the 109 recorded Indian mealy bugs and scale insects, 79 are indigenous, 6 are doubtful and 24 are introduced. It may be remembered that scale insects are very small and fixed to the plant, that they are often dormant for long periods on the plant, and that they are often parthenogenetic, requiring only the introduction of one female to start the species; it is thus that they are so frequently carried from country to country on plants and that there are so many recorded cases of actual introductions of these injurious insects.

This completes our review of the insects injurious to crops; if we include also insects injurious to grain, flour, stored produce, etc., we get the following facts; out of thirty species, twenty

are "cosmopolitan," some of which probably originated in India (*Calandra oryzæ*), while others have undoubtedly been spread by man and brought into India in merchandise. Probably fifteen out of our thirty have been so introduced.

What is the total result? Of our crop pests, exclusive of scale insects and mealy bugs, out of 213 species injurious in some degree, two moths and six aphides are possible introductions; out of 109 scale insects, 24 are probably introduced and of the most injurious ones, eleven out of fourteen are introduced; of thirty grain pests, probably fifteen are introductions. These facts mean that, of our important pests, only a very small proportion have been introduced, that these are either scale insects, grain pests or special insects, and that, as a whole, our crop pests are those produced by nature in the country and not those brought in by man. We may attach little importance to the scale insects that have been introduced because they are, as a rule, comparatively harmless in India; only permanent crops such as tea and coffee suffer from such insects and, while coffee is the prey of the green and brown bugs, it is much more the victim of depression, and the tea industry, if it suffers at all, suffers from indigenous rather than introduced species.

We may wonder why so few pests should have been brought in and, though one can but theorise, it is worth consideration. The principal fact to be borne in mind is the difficulty an insect would have in establishing itself and spreading, on account of the climate. In temperate regions, cold is the insect's enemy, and every insect meets this by dormancy. In India, fierce dry heat is the insect's enemy, and the greatest check in insect life is that period before the rains when all is parched and very hot. We know that insects, accustomed to a cooler, moister climate, have wandered into India and adapted themselves to the climate; the mustard Sawfly (*Athalia proxima*) is dormant from March to November; the cabbage white (*Pieris brassicæ*) goes to the hills in April; the wheat aphis (*Toxoptera graminum*) seeks shelter in the depths of the grass roots; in different ways insects adapt themselves, but these have probably done it gradually,

moving in from cooler to hotter areas step by step. It is probable that it is practically impossible for an insect to establish itself, if not accustomed to such a climate; and we believe this to be the great safeguard, the real reason why Indian pests are Indian, and are not cosmopolitan or European. Were India bounded on the North by agricultural countries with a profusion of pests, many more might have wandered gradually in; India is an isolated country and it is likely that those pests brought in by man failed to establish themselves owing to the rigours of a climate they were wholly unused to, unless there were very special circumstances, as in the case of Scale Insects on plants or weevils in flour or grain. The evidence derived from an examination of the origin of our existing agricultural pests is re-assuring and, with the few prominent exceptions, points to natural immunity from undesirable introductions, due partly to the natural isolation of India, but largely to its climate.

ARTIFICIAL FERTILIZERS FOR COTTON, CENTRAL PROVINCES AND BERAR.

By D. CLOUSTON, M.A., B.Sc.,

Deputy Director of Agriculture, Central Provinces.

It has been repeatedly pointed out that the black cotton soil of the Central Provinces and Berar is deficient in humus, the great source of nitrogen in any soil. The supply of farm-yard manure available is altogether inadequate to meet this want. Moreover, the decomposition of organic matter is much more rapid than it is in temperate climes, and is still further accelerated by the free aeration of the soil owing to its peculiar nature of cracking. White ants also play an important part in consuming vegetable matter in the soils. The cropping systems in vogue, too, tend to exhaust the soil's natural fertility without giving anything in return. In the cotton tract especially, the cultural methods and rotations practised are of an exhausting nature. Much of the crop, including cotton, gram, linseed and wheat, is pulled up by the root, so that the amount of crop refuse left in the field is very little. In this tract, moreover, cotton or cotton rotated with juar is grown year after year in the same land at the expense of leguminous crops, the chief soil-renovators made use of in other tracts of the provinces. So long as the price of cotton remains as high as it is at present, there is little hope of the cotton growers paying much attention to rotations unless an equally profitable crop can be found to rotate with it. The cultivator naturally looks more closely to his immediate profits than to the question of soil exhaustion and pecuniary loss 20 years after this does not matter so much to him.

(2.) The greatest need of cotton growers in these provin[illegible] at the present time is an additional supply of manure to m[illegible] the loss sustained by constant cropping. Artificials in the for[illegible] of nitrate of soda or sulphate of ammonia will, we believe, [illegible] some extent meet this want. The series of experiments wi[illegible] artificial manures that is now being carried out at the Nag[illegible] Experimental Station has so far given strong evidence in fav[illegible] of this opinion. Great care was again taken this year to sec[illegible] an equal number of plants on each plot; the number on e[illegible] after the last thinning being 1,664, or at the rate of 6,640 p[illegible] acre. To these plots the manures were applied at the rate [illegible] 126 lbs. of nitrate of soda, 80 lbs. of sulphate of potash a[illegible] 360 lbs. of superphosphate per acre; these supplied 20 [illegible] nitrogen, 35 lbs. of potash and 50 lbs. phosphoric acid respectiv[illegible]

The results are tabulated in the following statement

Plot	Manures applied	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
				Rs. A. P.	Rs. A. P.	Rs. A. [illegible]
1	Nitrate of soda, superphosphate and potash	720	280	44 14 0	30 7 0	13 [illegible]
2	Nitrate and super	620	230	26 0 [illegible]	25 [illegible] 0	10 [illegible]
3	Nitrate and potash	706	336	40 1 3	20 3 0	19 [illegible]
4	Nitrate	652	264	33 14 3	15 1 0	18 [illegible]
5	Potash and super	381	[illegible]	[illegible] 10 6	15 6 0	12 [illegible]
6	Super	245	104	11 15 9	10 4 0	[illegible]
7	Potash	325	24	2 10 9	5 [illegible] 0	7 [illegible]
8	No manure	390				

(3.) Nitrogen is conspicuously deficient in this particular [illegible] and the effect of the nitrogenous fertilizer in increasing the [illegible] turn is, therefore, surprisingly great. Without it, potash [illegible] phosphate are apparently altogether ineffective. The gain [illegible] to superphosphate and potash, when applied along with nitr[illegible] though considerable, will not justify us in assuming that [illegible] are deficient in this soil. Nitrogen is the all important const[illegible] ent, and when applied in *such a soluble form* is a highly [illegible] manure. The increased growth due to it makes heavy dem[illegible] on the other important constituents of plant-food, *viz.*, p[illegible] and phosphate, within the short period of three months, [illegible] the time of applying the nitrate to the time the cotton mat[illegible]

The application of the other two constituents enables the nitrate to exert its full effect in this short period of time.

(4.) From an economic point of view, nitrate of soda has proved to be a most profitable manure despite the fact that the price paid for that manure, including, as it does, freight charges on small lots from Calcutta is abnormally high. It would be bad agricultural practice, however, to apply only quick-acting fertilizers to a soil that is so deficient in organic matter as is the black cotton soil of these Provinces. What is required is some organic manure such as cattle-dung with an additional dressing of a highly soluble nitrogenous fertilizer. To ensure a liberal supply of potash, the urine should be carefully conserved along with the dung.

(5.) The experiments started last year at the Akola Station with the object of ascertaining what is the best combination of these to apply, failed to throw any light on the point owing to the abnormal character of last year's Kharif season. The outturn of cotton on three-fourths of the cotton tract was 50 per cent. below that of a normal crop. The growth of the plants being stunted by the excessive and continuous rains of July and the first half of August and by the severe drought which followed, cotton suffered more than usual from stem-borer this year. Nitrate of soda would seem to be a most effective preventive of this pest. Of the 13,312 plants grown on the 8 plots of the series, only 6 plants were found affected with stem-borer, and these were all found in the last four plots, i.e., the plots that got no nitrate of soda. It was noticed, too, that other cotton manured with this fertilizer on the farm was free of stem-borer. It is just possible that the use of such quick-acting nitrogenous manure may prove the most economical method of preventing pests of this kind which usually attack stunted plants that have suffered from untoward conditions of weather or soil.

(6.) The best time to apply the fertilizer is another problem that requires to be solved. The experience gained last year has convinced us that in the Central Provinces and Berar, where an early and sudden cessation of the rains is always possible,

top dressing is not an altogether satisfactory method of apply nitrate of soda. If applied before the plants have reached a hei of about 9 inches, it kills some of them, while if not applied the plants are sufficiently strong, there will be the risk of getting a late shower to dissolve the fertilizer, as happened year. Taking one year with another, it will most probably found that these fertilizers are most effective when applied at time of sowing.

(7.) Whether nitrate of soda or sulphate of ammonia i be the more suitable manure for the needs of cultivators in th Provinces is another problem that we hope to solve shortly latter is to be manufactured in these Provinces, and it should possible to make it on the spot at a much cheaper rate per un nitrogen than is paid for the imported material. More sulphate of ammonia being a less soluble manure, the proper t to apply it is at the time of sowing. With a short and capri rainfall, this too will undoubtedly be in its favour.

(8.) Nearly two tons of nitrate of soda were either sold given gratis last year to members of the District Agricult Associations, mostly in Berar. For reasons already explained definite results are likely to be obtained from these trials most cases the manure was not applied at all as the rains ce before the plants had attained the height at which it should h been applied. The only cultivator who has yet reported results obtained an increase of 212lbs. of unginned cotton from use of nitrate of soda at the rate of one-half cwt. per acre.

IMPROVEMENT OF CATTLE IN BENGAL.

BY E. SHEARER, M.A., B.SC.,

Imperial Agriculturist, Agricultural Research Institute, Pusa.

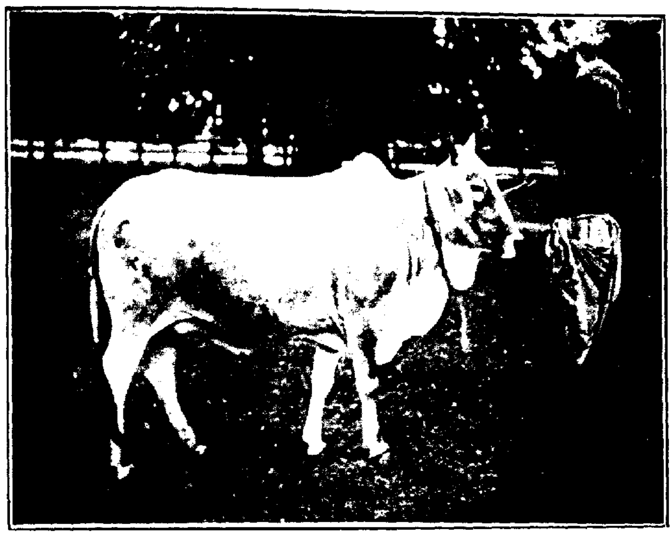
FROM the point of view of climate and of agriculture, Bengal may be said to be divided into three main tracts: (1) Lower Bengal, (2) Behar, and (3) Chota Nagpur and the hilly portions of Orissa. The conditions in the latter tract are in every way widely divergent from those in the rest of the province, and in this article only Lower Bengal and Behar will come under review. Speaking generally, in both these regions the soil is extremely fertile and the rainfall is usually plentiful or sufficient. The cultivation is consequently of an intensive character. In Lower Bengal, where the rainfall is heavy and well distributed over the year, wet crops, such as paddy and jute, are principally grown. In Behar, with a lighter rainfall, paddy is usually confined, except where there is canal irrigation, as in Shahabad, to the lower lying lands, but a great variety of dry crops is grown, much of the land ordinarily bearing both a kharif and a rabi crop in the same year. The population which is almost wholly agricultural is very dense, often exceeding 1,000 to the square mile.

In this country the common experience is, that the quality of the cattle varies inversely with the intensiveness of the cultivation, and hence it is hardly surprising that Bengal cattle are the worst in India. It is almost entirely a question of food supply. For many generations the cattle have been consistently starved, and the result is seen in the degenerate specimens existing to-day. Over the greater portion of the Bengal plains, grazing is very limited. In the Shahabad, North Darbhanga and

North Champaran districts of Behar there are still considerable expanses of waste land, and there some quite good cattle and certainly the best in Bengal are to be found. With the pressure of population these grazing areas are continually being encroached on. In Darbhanga district they are said to have contracted twenty-five per cent. within the last few years, and in Shahabad the opening of the Sone Canal has brought a great deal of what was previously waste land under cultivation. In most of Behar and still more in Lower Bengal, grazing supplies only an infinitesimal portion of the food required by the enormous numbers of cattle. The remainder is very inadequately supplied from the fodder available from the field crops. In Behar the average cultivator's bullock is a starved, stunted, weedy-looking beast. It is active but quite incapable of hard or prolonged work. The tillage implements are of the lightest character and only the easy working nature of the soil makes decent cultivation at all possible. Even as it is, by better tillage alone, Behar could probably be made to yield fifty per cent. better crops. The cows are worse comparatively than the bullocks, for the latter have the first call on the food supply. They usually yield a negligible quantity of milk, and the young stock, especially the young female stock, are consequently starved from the beginning. In Lower Bengal we find the same state of things, only in a more intensified degree. The cattle are probably of the same stock originally as those of Behar, but they have become still more diminutive and tillage implements have been reduced in size correspondingly.

If, then, we except Shahabad and certain portions of North Behar, where a fair number of moderately good cattle is produced, the condition of the cattle in Bengal could not well be worse. The Bengal Government has recognised the necessity of doing something to remedy this state of affairs, and within the last few years herds of selected cows have been established at Siripur, and by arrangement with the Government of India, at Pusa, for the purpose of breeding bulls of a superior type for distribution in the province. The cows for these herds have been selected by the Bengal Civil Veterinary Department from the Shahabad district

PLATE XXXVII



I. J. F.   C... PUSA HERD

chiefly. The object is to produce compact, well-built bulls with good bone, but not too large since they will have to mate with small cows. Representative cows and the present stud bull of the Pusa herd are illustrated (Plates XXXVII, XXXVIII). The cows have not been selected for their milking powers. The sole object at present is to produce bulls which will beget better work cattle.

It may be asked how far the method adopted for the improvement of cattle in Bengal is likely to succeed. There is no doubt that there is a great scarcity of good bulls all over the province, and all that Pusa and Siripur can supply will be eagerly sought for. Such bulls also should have a considerable effect in raising the standard of work cattle in the districts which they serve, for the cultivator usually does the best he can by his male young stock. On the other hand, the area of the province is enormous, and at the best, only a comparatively small portion of it can ever be supplied with these better bred bulls. Unless the cultivators can learn the lesson of what can be done by selection and breeding, and themselves carry on the work, little permanent improvement can be looked for. The weakness of the present method of improvement (apart from the impossibility of supplying more than a fraction of the number of bulls required), is that all the attention is being concentrated on the bulls, while no account is being taken of the cows. However good the bulls may be, no good stock can be produced if the cows continue to be starved and neglected as they are now, and there is little doubt that they will continue to be starved and neglected until the cultivator obtains a better cow. The fact is, that at present the average cow is such a wretched specimen that the cultivator cannot afford to feed her better than he does. Practically, the only return which she gives for her food is her calf, and that is not enough. What he wants is a good milch cow which will not only rear a calf but leave a substantial surplus of milk to her owner. Such a cow he is prepared to pay for and prepared to feed. It is surprising how little more a good milch cow eats than a bad one. She is simply a more efficient animal.

To produce for Bengal a type of cow which will be a good milker, and at the same time breed work cattle of the type required for the province, does not seem to be impossible of realisation. It may take many years, but until such a type is produced, I strongly believe that no substantial or permanent improvement in the cattle will be effected.

PLATE XXXVIII

Bull, Pusa Herd.

THE JORHAT AGRICULTURAL AND INDUSTRIAL EXHIBITION, HELD ON 12TH FEBRUARY 1908.

BY S. G. HART, I.C.S.,

Director of Agriculture, Eastern Bengal and Assam.

THE Jorhat Agricultural and Industrial Exhibition was opened on the 12th February 1908, by Sir L. Hare, Lieutenant-Governor of Eastern Bengal and Assam. It remained open till the 26th idem and drew large crowds of visitors.

The exhibition was held in a temporary building erected on the *maidan* adjoining the Sub Divisional Offices. A great deal of care had been bestowed on the decoration of the buildings and the laying out of the grounds. At night the whole place was lit up by the 20th Century Light.

All the arrangements of the exhibition were carried out by a local committee, of which the Sub Divisional Officer was Chairman. The Gossains (high priests) of the Majuli, European planters and all other classes of the community took a large and active interest in the promotion of the exhibition and contributed about Rs. 11,000 of the total cost, the balance of about Rs. 4,500 being contributed by the Local Boards of the district and the Agricultural Department.

The original intention of the promoters of the exhibition was to restrict its scope to the Assam Valley districts. But in consequence of advice and suggestions received from various quarters, and considering that a show limited to Assam Valley might be deficient in educational value and attractiveness, the committee decided to extend its range to include interesting exhibits from outside Assam proper. An exhibition on this scale is the first attempted in the province of Eastern Bengal and Assam. Exhibits were received from almost all the districts of

Eastern Bengal and Assam and also from Manipur, Calcutta, the 24-Parganas, Hooghly, Howrah, Midnapore, Bankura, Cawnpore, Dehra Dun, Kistna (Madras), and Jaipur. The exhibits were arranged in two main groups—(1) Agriculture and Forestry, and (2) Industry.

AGRICULTURE.

Every important crop of Assam was well represented and numerous exhibits of special interest were received from outside the valley.

The Inspector of Schools, Surma Valley, sent in a comprehensive collection of agricultural products of that valley and there were similar private collections to illustrate the cultivated plants of the Assam Valley.

The Sibsagar Forest Division contributed a representative collection of timbers indigenous to Assam.

The Agricultural Department sent a special exhibit which included cocoons of the European Univoltine silkworm, raised at the Shillong Farm, lemon-grass oil from the Government Tropical Plantation at Wahjain, several varieties of American sweet potatoes grown at Shillong, cigars from the Rangpur Experimental Farm and specimens of canned and bottled fruits and vegetables. Another interesting feature of the department's exhibits was a collection of the more important insect pests illustrated by actual specimens or illustrations, together with samples of various insecticides and appliances for destroying insects. Copies of a printed note (in English and Assamese) on these pests were distributed.

Another collection of injurious and beneficial insects was exhibited by Mr. C. B. Antram, Entomologist of the Indian Tea Association.

Special mention should also be made of several exhibits of exotic rice grown in Assam, a collection of nearly 400 varieties of paddy exhibited by the Superintendent of the Jorhat Farm, various specimens of cultivated and wild fibres, among which were Spence's cotton, jute, *mestapat*, Mauritius, sisal and other

agaves, flax, sida, pineapple, rhea, *hibiscus mutabilis* and plantain fibres. Some of the samples of jute exhibited for length, strength and lustre would hardly be surpassed anywhere in Bengal.

The best collections of fibres were exhibited by Mr. Finlow, the Government Fibre Expert, and Babu Mangobind De Choudhury, proprietor of a farm near Silchar.

Of groundnuts, a crop new to the province, a very good sample was exhibited by the same gentleman from Silchar.

A fair collection of agricultural implements of improved types, more or less suited to the circumstances of the country was exhibited, among which the Hindustani plough and the Planet Junior Hand hoe have been favourably reported on by the Agricultural Department.

INDUSTRY.

Textiles were well represented. Besides a large assortment of yarns and of plain cloth woven from cotton, Eri, Muga and Pat (mulberry) silk, there was on view a great array of muslins and embroidered goods, both from within and outside the Assam Valley. Fine cloths, an art in which Assamese ladies specially excel, as also fine silk and cotton cloths embroidered with silk and gold thread were exhibited, together with the pattern from which they were woven. In these patterns in which thin strips of bamboo take the place of the warp threads, the design of the cloth is given on a magnified scale.

Several exhibits of crochet work deserve mention as showing proficiency in a newly introduced art.

The weaving exhibits included several improved hand looms. Besides the "Triumph Automatic" loom of the Salvation Army, and Mr. Chatterton's adaptation of the Hattersley loom, a loom invented by Babu Mahendra Chandra Nath of Kalikacha, in Tippera district, was interesting on account of its efficiency combined with low price.

Among the art wares were some fine specimens of silver filigree work from Dacca and Cattack, ivory work of Jorhat,

Murshidabad and Manipur, models in papier mache, wax and clay of various places, and especially some costly exhibits of gold jewellery with enamel work inlaid an old art which now survives only in Jorhat town.

The one feature of the show was the number of articles which not long ago were never made in India but entirely imported from abroad. These included soap, candles, leather goods, cutlery, stationery, hosiery, etc., all evidencing an industrial awakening, though only a small proportion came from the Assam Valley.

The inventor of the Kalikacha loom also exhibited an ingenious machine for making matches. It is worked entirely by hand and the total cost is only Rs. 150.

The technical schools of the Province showed some good relief maps, astronomical maps, models, etc., made by pupils.

Earthen-ware roofing tiles (similar to those of Raniganj), manufactured at Itakhola, A. B. Ry., were exhibited by Babu Prakash Chandra Roy and were very favourably reported on.

FURROW IRRIGATION.

By ALBERT HOWARD, M.A., A.R.C.S., F.C.S., F.L.S.,

Imperial Economic Botanist.

ONE of the first questions that has to be considered in connection with experimental work in the field in India is the best means of applying irrigation water. The present paper is written with the object of recording the writer's experience in this matter at Pusa during the last three years.

The usual methods of watering plants in India are well known and need not be described in detail. Where water is abundant, as for example in the Canal Colonies of the Punjab, the surface is divided up into beds (*Kiaris*) and flooded. In well irrigation, in the United Provinces, a similar method is used, except that here the *Kiaris* are much smaller in size. In gardens, basin and trench irrigation are to some extent employed, but it has often appeared to me that much remains to be done in India to improve this latter system of watering.

The disadvantages of flooding the surface are well known. Besides the destruction of the tilth and the formation of a surface skin (*papri*), which becomes hard and impervious on drying, this method leads to a great loss of water by evaporation. Moreover, in many cases, percolation is slow, as the air in the soil can only escape very slowly laterally. Further, flooding the surface often leads to an infertile condition of the soil, due possibly to the partial destruction of the bacterial flora thereof.

In order to overcome the disadvantages of surface flooding and also to economise water, a method has been devised which combines the advantages of furrow irrigation, basin irrigation and irrigation by lateral seepage and at the same time allows of a proper surface tilth being maintained. The method can be

applied both to orchards and to crops like tobacco, ganja, cotton, patwa, etc. It has been found to be particularly valuable in the case of newly planted fruit trees and for crops like tobacco and ganja, which have to be transplanted in the field from the nursery.

In orchards the method adopted is as follows :

A trench about a foot wide and four inches deep is laid out parallel to the rows of trees. Each tree is then surrounded by a similar furrow ring, the position of the ring corresponding to the outer spread of the branches. In newly planted trees the mean diameter of the furrow ring is from 3 to 4 feet. The rings are joined up to the longitudinal trench by short connecting trenches by means of which the rings can be cut off by an earth fillet from the longitudinal trench. The following diagram will make the arrangement clear.

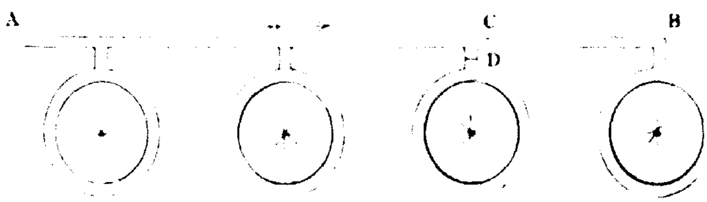


FIG. 1

In carrying out this system in practice, water is allowed to run down the trench AB to B, the furthest point from the main distributing channels. The last ring is then opened and allowed to fill. As soon as this takes place, the main trench is filled at C with a fillet of earth and the connection at D is opened. The second ring is now filled and so on. In this way there is no stoppage of work and the tree is not only supplied by the water in the ring but also by that in the section of the trench CB.

With young trees the rings are filled up after every monsoon and re-made on a larger scale at the beginning of the next hot weather after weathering and manuring have been done. The longitudinal trenches are left during the monsoon as these serve as drainage channels and prevent local water-logging.

In planting new trees this system of irrigation has been found most useful. After the holes have been dug for the trees and filled in, the rings are made and the irrigation water run into these *before* planting. By this means any shrinkage and subsidence of the soil takes place before planting, and can be adjusted. Moreover, the young trees have the benefit of being planted in a moist soil. February and March are the best months for planting young trees in Behar, and by this means they can be established before the heavy rains of the monsoon in July and August.

In connection with the manuring of trees this system of irrigation has proved most useful. One of the difficulties in applying manure to fruit trees in India is the subsequent damage done by white ants (*Termites*), which are attracted by the organic matter of the manure and frequently turn their attention to the tree and destroy it. If the trees are manured just before the rings are made, and if care is taken to apply the manure only to the ring of soil just underneath the outside branches, the first watering not only tends to rot the manure but also to drive off the *Termites*.

This ring method has great advantages over the basin method of irrigating fruit trees, which is practised by the cultivators in India. In the basin system (Fig. 2), a shallow circular hole is excavated round the base of the tree, and these basins are connected up by short trenches between the trees.

Fig. 2.

In the first place, trees like Citrus plants are not benefited by water lying round the base of the stem and are then often attacked by the "collar rot" disease. Secondly, the water is not applied directly to the young roots of older trees, while in young trees they are apt to be water logged. Lastly, this method does not facilitate manuring and drainage in the monsoon.

In the case of transplanted crops like tobacco and ganja th[illegible] system becomes one of modified furrow irrigation. The gre[illegible] danger in growing a crop like tobacco, especially where th[illegible] autumn rains fail, is the loss of plants which occurs on tran[illegible] planting them in the field and also from grasshoppers. The usual method in India is to transplant in the evening, to wate[illegible] the young plants and to cover them with *san* leaves during th[illegible] heat of the day. Even when every care is taken, many pla[illegible] die. In plant-breeding work, this loss is of great importa[illegible] owing to the danger of a dead plant being replaced [illegible] one of a wrong variety. In order to minimise this loss, [illegible] have devised the following method. After cultivation [illegible] manuring are finished, furrows about one foot wide and [illegible] inches deep are laid off at the proper distance, so that there [illegible] be a furrow between alternate rows of tobacco.

These furrows are then filled with water several times, [illegible] the water is allowed to percolate laterally until the soil is [illegible] moistened between the furrows. Transplanting is now car[illegible] out in the soil moistened by lateral seepage from the trench[illegible] and the young plants are covered with [illegible] leaves during [illegible] day which are removed at night. (See Plate XXXIX.) Wh[illegible] this method is used, the loss of plants is not more than one [illegible] cent., and there is practically no danger of destruction by gras[illegible] hoppers. During the last year when the failure of the autu[illegible] rains almost destroyed the tobacco crop of the cultivators [illegible] district, no difficulty was experienced in growing good tobacco [illegible] Pusa. Subsequent irrigation is done by filling the trenches [illegible] the same manner as that adopted before transplanting.

PLATE XXXIX.

A. J. I.

Furrow Irrigation at Pusa with Tobacco.

NOTES.

Potash Manures.—The February Number of the "Agricultural Gazette" of Tasmania contains an interesting extract from "The Farm and Home" on Potash Manures. The writer points out that potash manures are less understood and favoured, though not actually less important, than nitrogenous and phosphatic manures. The action of potash manures depends very much upon the soil, so that individual experiment is more necessary with this class of manure than with any other. Soils with clay in their composition generally contain potash, and here the application of potash is seldom followed by any benefit. For with such soils, the application of the ordinary (non-potassic) manures very often sets free the locked-up resources of the soil. Alkaline manures (e.g., those containing lime or soda) decompose the insoluble silicates and liberate potash in an "available" condition. When nitrates are used, the root system goes deeper in the soil, and thus there is a wider range from whence the plants may extract their food supply.

While nitrogen encourages growth and bulk, and phosphates promote early maturity, the special function of potash is, to some extent, to improve the quality of the crop. With wheat, for instance, the effect of nitrogen and phosphates is to increase the number of grains, but it is left to the potash to secure plumpness and quality in these grains. Crops cultivated for their pods (*e.g.*, groundnut, gram, etc.), or for their leaves (*e.g.*, tobacco, cabbage, etc.) and root crops valued for their starch (*e.g.*, potato, yam, etc.), are particularly benefited by potash. In the same way with fruit trees, the potash encourages good colour and flavour in the fruits, specially in those which contain sour

juices. In this connection Mr. N. G. Mukerji mentions a interesting case. In the Berhampur Jail, there were hundre of lime trees which never bore fruit, although they were matu Application of potash manures was advised and it was reward with a large return of fruit in the very same year. In Beng the peasants look upon wood ashes as the best manure f bananas. Potash is also a very useful manure for cigar-maki tobacco, having some effect in making the cured tobacco bu properly. Then, again, potash strengthens the stems of grass and of cereal plants, thus enhancing the feeding value of th straw and facilitating the formation of good grain.

Another effect of this manure is its power of rendering pla less susceptible to fungoid diseases, it having been found useful checking rust in wheat. This is probably because it encourag vigour in the plants. Potash manured crops continue their gr ing period later than others which is advantageous with su crops as potatoes. With other crops (barley, for instance), t effect might be disadvantageous.

Three potash manures are ordinarily available, viz., Kaini Sulphate of Potash and Muriate of Potash. The first co from the natural deposits in Strassfurt (Germany). I unnecessary to enter into the details of their application as t manures are not largely used at present in India. Here commonest form in which Potash is used is in the form of h hold ashes. Potassium Nitrate and cattle urine are the Potash manures ordinarily available in India, and the forme generally cheap at ordinary prices.—J. Sen.

∴

Uses of Silt in the Madras Presidency. In the Ma Presidency, cultivators are well aware of the value of silt as manure. Large quantities of silt are dug out of tankbeds e year and carted to the fields. In some parts, the right of t ing silt from the irrigation canals is put up to auction, an t silt thus bought is put on to rice lands as manure. The cost carting is considerable. In dry lands, silt from tanks and

sources is largely used as manure for top dressing. It is also used to improve saline and badly drained low-lying lands. The silt of some rivers in the Punjab as well as in Madras is considered to be more valuable as manure than that of other rivers.

Owing to the greater manurial value of the silt contained in the red water drained from the Western Ghats, the ryots of the Krishna Delta prefer it for irrigation to that of the grey water drained from the Eastern hills. The first flood of any river in India is held to contain silt of greater manurial value than later in the season, as it carries down all the decayed vegetable matter accumulated on the soil during preceding many months or so. Unfortunately, on account of the denuded conditions of the hills, the silt brought down by many of the rivers consists of coarse sand and light gravel and is useless as a fertilizing agent.

There is a project for constructing reservoirs on the Krishna, the Tungabhadra and the Cauvery, and it is expected that these reservoirs will form great silt traps. The value of silt as manure is being tested at the Hagari Experimental Farm, and the result will, no doubt, be very useful to cultivators.

Reclamation of waste lands by silt deposit does not appear to have been tried in the Presidency on any extensive scale. There is ample room for such trials on the waste lands on the Malabar Coast and elsewhere.—Editor.

∴

The Solar Motor.—Recently a novel machine, known by the name of Solar Motor and worked by the heat of the sun's rays, for raising water for irrigation, is claiming attention chiefly in the United States of America. It is a steam engine driven by the concentrated rays of the sun. It consists of a reflector and a boiler. The reflector is in the form of a truncated cone 35 feet in diameter across the top and 17 feet at the bottom. It intercepts about 1,000 square feet of sunshine and reflects it on the boiler which is a copper tube about nine feet long and twelve inches in diameter. It is rigidly fixed in the centre of

the reflector and revolves with it. The reflector swings round and follows the sun as a result of a simple clock-work device. The boiler supplies steam at a pressure of 150 lbs. per square inch to a steam pump. Both reflector and boiler are mounted on supports.

It is said that the whole machinery works almost automatically. All that is required is to focus the reflector in the morning and start the clock work. It takes about one hour to raise the steam. The power for work depends upon the time the sun is above the horizon.

A Solar Motor of ten-horse-power engine capacity can lift about 1,400 gallons of water per minute from a depth of 12 feet. It costs in America £400 or Rs 6,000. These Solar Motors are chiefly used at present to work pumps for irrigating the dry lands in California, where one motor suffices to irrigate from 150 to 400 acres of land according to the kind of the crops. The farmers pay from £2 to £3 an acre for such irrigation.

To set up a ten horse-power Solar Motor in India, the cost will probably be over Rs. 10,000. Allowing 4 per cent. interest, 10 per cent. depreciation, 5 per cent. for repairs and Rs 360 a year for maintenance, the total working expenses will come to about Rs. 2,260 a year. The Solar Motor in India would not be of extensive practical use, unless it lifted water 30 or 35 feet from rivers, lakes or tanks. The ten horse-power motor, with depth to water 35 feet, would not irrigate a larger area than 100 acres of perennial crops or perhaps 200 acres of mixed crops, sown at different seasons in succession, each of which takes four or five months to mature. The approximate cost per acre for irrigating perennial and ordinary crops will therefore be Rs. 22-8-0 and Rs. 11-4-0 respectively.

These charges are, no doubt, small when we know that in Bombay Presidency it costs a good deal more to irrigate fields with well-water lifted by ordinary country appliances. It is very doubtful if Solar Motors can be economically used for well irrigation in India, as in average years the water of a well is ordinarily sufficient for only 3 or 4 acres in Peninsular India and

for 20 acres or less in the United Provinces and the Punjab. A Solar Motor can possibly be economically used in lifting water from large tanks or other reservoirs or from perennial rivers and streams. Even in the case of reservoirs, a Solar Motor will only be useful for brief periods when the water gets low. It will be of no use for a considerable portion of the year when the flow is usually by gravitation. In the case of rivers, it would be cheaper, where possible, to irrigate by flow through a canal system. Along deep banked slow running streams, there are, however, numerous positions where considerable areas could be irrigated by raising water 30 or 35 feet.

Besides the limitation imposed by the supply of water, there is another condition, *viz.*, the supply of sunshine which considerably restricts the use of the Solar Motor in India. There is little sunshine during the rains when most of the irrigated crops are grown. In Northern India the hot season is not suitable for the growth of any but one or two special crops. In winter the sun is not hot enough for a Solar Motor to work successfully. In Madras the Solar Motor will stand no chance against the oil engine, because the capital cost of the latter is only a quarter of that of the former and the fuel charges are not high. Moreover, the Solar Motor is not at all likely to prove of use to the Indian cultivator as it requires skilful adjustment, delicate handling and skilled labour to repair.

A Solar Motor, based on the action of the unconcentrated rays of the sun, has recently been invented in America. By storing power in hot water, this motor has been worked night and day. The whole plant is entirely automatic. The total cost is as follows:—

	£
Cost of sun heat absorber 20' × 20'	30
Cost of storage tank for hot water	5
Cost of turbine condenser and pumps required for handling the condensed water	70
Cost of freight in erection in India	50
...	[illegible]

This does not include the cost of a pump required to lift the water from a reservoir or river.—(EDITOR).

∴

PUNJABI REAPING-HOOKS.—It has frequently been observed that the cultivators of the various agricultural tracts of India have much to learn from each other in the details of agricultural practice, and that much good can be done by introducing into a district some practice adopted in other parts of India. The writer has been impressed with the need of further work in this direction and ventures to bring this note forward as a minor example of what is meant.

In the Canal Colonies of the Punjab labour is scarce and dear at harvest time, and part of the wheat crop has to remain standing on the ground for some time after it is ripe for the want of reapers. So great is the demand for labourers that European labour-saving devices, such as reaping machines, are being tried and will probably be adopted widely. The method of the people in reaping is very much the same here as in other parts of India. The crop is cut by hand by means of a small reaping-hook (*hansua*). The intermediate method of mowing by scythes does not seem to be practised and is probably too laborious for adoption in India where the labourer loves to squat and occasionally have a rest. I have never seen mowing done in India as it used to be done in England before the adoption of reapers and self binders.

In the wheat harvest of 1907 my attention was arrested by the comparatively greater efficiency of the reaping sickle of the Punjabi peasants over that used in Behar. A sample was taken to Pusa and this year placed in the hands of a *Kurmi* cultivator employed in the Pusa Botanical Gardens. He was able to reap much faster with this than with his own tool and was much impressed with its advantages over the local sickle. Accordingly, a supply of copies was made in the local bazaar from the original brought from Lyallpur in 1907. The local reaping sickle is

shown in Fig. 3 A, while B & C illustrate the ones in use in the Punjab.

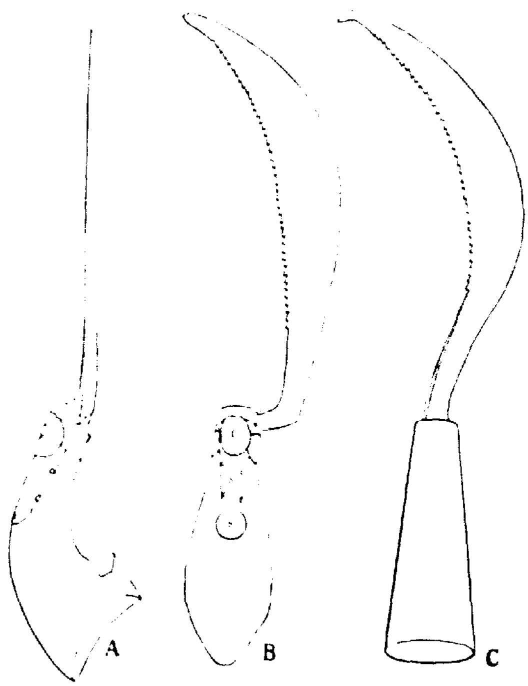


FIG. 3. REAPING-HOOKS.

The advantages of the Punjabi hook are to be found in the protection given to the hand by the curved handle and in the more scimitar curve in the blade. The price of the Behar sickle is said to be 1½ annas, while the one brought from Lyallpur cost me four annas. I have, however, not been able to ascertain what the local price for these articles usually is among the people themselves. The prices given are no doubt only of comparative value. (A. HOWARD).

∴

THE PLANTING OF DURANTA HEDGES.—During the recent meeting of the Board of Agriculture at Pusa, February 1908,

several inquiries were made by Members as to the method adopted in raising the *Duranta* hedges in the Botanical Gardens at Pusa. The present note has been written for the purpose of placing the writer's experience in this matter on record.

The best hedge plant for use in Behar is at present undoubtedly *Duranta plumieri*, Jacq. and very good hedges of this species are to be frequently seen at the stations of the Bengal North-Western Railway and in many private gardens.

The best of the methods tried at Pusa for raising good, even hedges of this plant is as follows :—

At the end of February, beds of cuttings taken from the mature wood are laid down in well shaded nurseries, and at the same time the site of the future hedge is determined and the soil dug out to a depth of three feet and left on the edge of the trench. In this way the soil becomes well aerated during the hot weather, and better results and a more even hedge were obtained by a previous preparation of this sort than by copious manuring even when assisted by a preliminary cultivation with the *Kodali* before planting.

Towards the end of the hot weather the trench is filled up and the earth allowed to consolidate and moisten during the early rains. When the soil is moist enough and subsidence has taken place, the rooted cuttings in the nursery are cut back, taken up with balls of earth and firmly planted out. At first they are covered with grass to shade them till new shoots begin to appear through the covering, when the grass is removed and the surface broken round the *Duranta* plants with a *Kurpi*. The *papri* (the surface skin on the soil produced by heavy rain or irrigation) is kept broken up from time to time during the monsoon and the hedge is kept free from weeds and grass, and any dead plants are replaced from the nursery. The young plants are kept cropped with shears and the hedge is allowed to grow up slowly and evenly. The preliminary cutting back on planting and the cropping with the shears produce abundant lateral shoots, and a thick-set, even hedge results.

The time of planting, however, is not of very great importance, provided the preliminary cultivation has been done in the manner indicated and provided rooted cuttings are available and also artificial irrigation. Very good hedges have been obtained by planting after the monsoon in October and also during the hot weather in May. In such cases, however, watering is essential. (A. HOWARD).

∴

A GOOD SCREENING PLANT. In the laying out of new compounds and in the building of new stations it is often desirable to screen off unsightly buildings and to separate one compound from another as quickly as possible. For this purpose a rapidly growing plant is necessary which at the same time can be kept in bounds and is not unsightly. For this purpose *Sesbania aegyptiaca*, Pers., is of considerable value. A thick hedge of this plant can be grown from seed 7 or 8 feet high in one year. Moreover, it can be cropped and kept neat during this period. Permanent hedges of *Duranta*, *Dodonea* or *Inga* can at the same time be planted parallel with the temporary *Sesbania* which can be removed when the permanent hedges are high enough. *Sesbania aegyptiaca*, Pers., is also useful as a temporary wind break on exposed land. (A. HOWARD).

∴

THE SETTING OF PLUMS IN BEHAR. Although various varieties of plums grow freely in Behar, nevertheless it sometimes happens that the trees fail to set fruit although there may be a copious blossom. Nearly all the varieties of plums at Pusa flowered heavily this year although the trees are very young. Only a few, however, set fruit, and in these cases the trees have had to be thinned to prevent the branches being broken by the weight of the crop. The contrast between the trees which set fruit and those which merely blossomed was very great. It was noticed that in all cases the early flowering varieties set fruit, while the late flowering varieties dropped their blossoms as soon as they opened. The result is probably due to the hot west winds which

began early this year, and experiments have been arranged at Pusa to see whether by judicious irrigation the fruit on the later flowering varieties can be made to set. In the meantime it appears desirable to suggest that the early varieties are the best to grow in Behar.—(A. HOWARD).

∴

TREE COTTON EXPERIMENTS IN BENGAL.—The experiments with perennial cottons undertaken by the Indian Long Stapled Cotton Growing Syndicate (Agents, Messrs. Shaw, Wallace & Co., Calcutta) have not proved the suitability of Behar to such cottons. The principal plantations at Maniarpur were twice (1905 and 1906) severely damaged by floods. The liability to flood of most of the parts of Behar makes them, in the first place, unsuited to the cultivation of tree cottons which are very susceptible to damage from excessive moisture. The firm consequently transferred in 1907 their operations to Mourbhanj (Orissa District) where a small plot of ground grown with tree cotton had given some promise of success. The total area planted at this place measures 230 acres. On this area are grown five or six varieties of perennial cottons of both Kidney and Naked seed types. These have been sown in different ways, *viz.*, on ridges, on mounds, on the flat, etc. Messrs. Shaw, Wallace & Co. may be congratulated on persevering with the cultivation of tree cottons on an extensive scale and in the face of many difficulties, the more so particularly as in many parts of India the experiments which have been carried out during recent years have mostly resulted in failure.

The firm recently sent to the British Cotton Growing Association, Manchester, two bales of lint of tree cotton, grown by them at various centres. The lint comprised some seven varieties of both Kidney and Naked seed types. The lint of most of these varieties was reported by the Association to be of very little value, being short in staple, full of crushed seed and stains and immature. The best sample was valued at 10½*d.* per lb. —(EDITOR).

CULTIVATION OF CARAVONICA COTTON IN INDIA.—About four years ago Dr. Thomatis professed to have evolved, by methods speedy enough to be accepted as magic, three remarkable varieties of tree cottons, the excellences of which he briefly summarised as follows: "The tree cotton will require only one planting, will necessitate but simple and inexpensive culture, will live probably a man's lifetime, will withstand and defy roaring floods and resist parching droughts, once in full vigour, size and growth. Its proportion of lint I am raising every year: it is now already 40 to 50 per cent. and will steadily increase every year, probably up to a seedless crop." He also claimed to have improved the percentage of clean cotton in the Kidney seed variety from 26 to 40, and stated further that it is a very hardy tree and a heavy and sure cropper in all kinds of seasons. This is entirely opposed to our experience of the plant in India, where it is delicate and a notoriously poor yielder.

In 1905, he wrote to the *Ceylon Observer* as follows:—"You will notice how well I succeeded in disintegrating or loosening the kidney-shaped group of seeds in the Kidney cotton, thus making ginning more practicable. I also succeeded in enlarging the size of the boll and in improving the staple altogether."

I have found, from personal observation of the plants in Poona, that the seeds are certainly loosened to some extent in the majority of examples but, on the other hand, they are disposed to coalesce in smaller groups, and this feature, looking at it from the ginner's point of view, is probably just as objectionable. He further states that it took three years to educate the trees but, unfortunately, he does not divulge his educational method.

In other communications to the Indian press he reiterates his statements regarding the superexcellence of his cottons. He professed to have no doubt whatever that the *sandy* delta of the Ganges and many river flats or beds and the extensive sea-shores can be made a prosperous home for his wondrous productions!

An article by a botanical expert in the *Madras Mail*, some time in 1905, is particularly valuable, as it gave clearly and

sensibly valid reasons why the pretensions of Dr. Thomatis should not be supported, and it deserves to be quoted at some length.

After briefly dwelling on the failures experienced in the attempts to introduce exotic cottons into India, the article winds up with the following pertinent conclusions: "Dr. Thomatis has said he expects to produce an almost seedless crop. It would be interesting to know how he has been improving his percentages of lint and, at the same time, been working to obtain a seedless variety. The two results are diametrically opposed to nature......... The cotton plant produces its fibre or lint on the seed itself and to produce a seedless cotton plant for the purposes of cotton growing is as easy of accomplishment as to produce or grow feathers without birds."

Dr. Thomatis, in 1904, said "Three years ago I collected scores of varieties of seed from all parts of the world, got samples of bolls and lint thereof and then chose two, both of the 'Sea Island' variety. .... I crossed them by hybridisation"

"To have obtained seed from all parts of the world, to have grown them to a flowering stage, to have hybridised and obtained seeds from these and to have raised plants from this seed capable of producing cotton, must have taken some considerable time, and when we remember that it was not until 1901 that Dr. Thomatis sent to different parts of the world to collect his seed, we may judge with how much authority he can speak of its habits and requirements, especially for Indian cultivation."

Now that we understand how the evolution of the Caravonica cottons was effected, we pass on to the relation of some actual experiences in the cultivation of these products in India itself. At Poona, in 1905, seeds of Caravonica No. 1 were received through the Inspector-General of Agriculture. Twenty-five were sown; of these, 12 only germinated and 10 plants were finally put out in good soil in a situation, sheltered but not shaded. After two years, only one plant had survived and that has yielded nothing. The principal characteristic of this variety was its extremely low vitality.

Thirty seeds of Caravonica No. 2, received at the same time, produced 15 plants which were put out in the same area as the above. In two years the individual variations of these were remarkable; the best was a plant with a height and spread of about 7 feet, three more had attained about half these dimensions and the remainder, weak and stunted all through, died off one after another.

Four plants only yielded cotton in the second year.

Plant No. 1—the largest was so brittle that some of its branches broke down merely with their own weight and others snapped during the prevalence of winds which were never more than moderate in the sheltered plot occupied by the plants.

In 1907, or in the second season of growth, this plant bore 21 ounces of seed cotton, producing 12 ounces of ginned cotton. This works out to a percentage of 57 which is extremely high of course, but is explained by the fact that every seed had been completely destroyed by insects. It would be interesting to know if Dr. Thomatis expects to arrive at his seedless variety by the same method. At the end of the season, the plant, which was in a severely crippled condition, was pruned back according to Dr. Thomatis' recommendation but, unfortunately, it died after the operation.

Plant No. 2—yielded 7 ounces of seed cotton and $2\frac{1}{2}$ ounces of clean cotton.

Plant No. 3—yielded 10 ounces of seed cotton and 5 ounces of clean cotton.

Plant No. 4—yielded 2 ounces of seed cotton.

The bolls and seeds of all were severely attacked by insects.

Two years ago I examined Caravonica plants on the Nagpur and Bellary farms, and found that they were all of the common stunted type. The only plant I have seen in any way answering to the glowing description of Dr. Thomatis was the plant No. 1 described above, and that was too brittle to retain its branches even in a sheltered position. Further experiments have assisted to prove the low germinating power of the seeds and the extraordinary diversity of the resulting plants. This latter character

is, of course, due to the recent hybrid origin of Dr. Thomatis' varieties. For his own reputation alone, he should have fixed his types properly before selling the seeds at such high figures.

Mr. R. C. Wood, Deputy Director of Agriculture, Northern Division, Madras, has written an interesting report on experiments with Caravonica cotton in Cuddapah.

The seed, obtained by a Bombay Syndicate direct from Dr. Thomatis, was said to be of poor quality and the percentage of germination was very low. Mr. Wood found that, although "Silk" cotton had been stipulated for all three varieties, *silk*, *wool* and *kidney* were to be found. The plants produced (as would be expected from a hybrid) were of many and varied types, in growth, habit and quality.

In this report, Mr. Wood repeats an often urged warning by pointing out the extreme danger perennial cottons have to face from insect attacks. Being perennial, they naturally afford food and shelter to pests which are carried on from one year to another and, in the event of the extension of tree cotton cultivation, which, however, is scarcely a possible contingency, there is always the chance of indigenous varieties in the vicinity being attacked.

In conclusion, I think it ought to be emphasized repeatedly and widely that cultivation, on a large scale, of perennial cottons whether American, Australian or otherwise should never be attempted in India.

Their very structure is that of denizens of wooded and sheltered localities; their brittle nature forbids their being grown in open fields exposed to winds; their naked seeds are the easy prey of every noxious insect that exists on cotton, and finally, the reasons which will perhaps appeal most strongly to the commercial world are, they never produce a full crop till the second year, the chances of absolute failure from climatic causes are carried on from year to year, the land becomes weed-infested, and the yield is never commensurate with the area that each individual plant covers.—(G. A. GAMMIE).

TOBACCO IN SOUTH CANARA.—Three varieties of tobacco are cultivated as a second crop after paddy in South Canara. The chief centre of cultivation is Kasargod and the three varieties cultivated are—

(1) *Neranki*, (2) *Natti* and (3) *Battayi*. *Neranki* corresponds to what is known in the Tamil districts as *Erumai kappal* (literally meaning buffalo boat) being characterised by long, broad and thick leaf. It is known to be more intoxicating when chewed than the other varieties. Water should be drunk when such effect is experienced. *Neranki* is darker green, more productive and hardy than the other varieties.

Natti corresponds to what is known in Tamil districts as *Oosi kappal* (literally needle boat). The leaf is long and narrow.

Battayi has a leaf of medium size, apparently corresponding to what is known in the Coimbatore district as *Vatta kappal* (literally round boat). It is comparatively bitter or acrid to the taste.

Tobacco is chiefly grown for chewing and to some extent for making snuff.

Soil. Though sandy soil is generally unsuitable for growing tobacco owing to its marked deficiency in potash, this class of soil on the sea coast in South Canara, especially in the Kasargod Taluk, is successfully cultivated with this crop, with the aid of fish and cattle manures. Strange to say, tobacco is not cultivated in the neighbouring sea-board of the Malabar district.

Omitting the points of cultivation which are the same as in other districts, I shall only mention the peculiar features of tobacco cultivation in South Canara.

The planting is done about the end of October. The seedlings are planted $3\frac{1}{2}$ feet apart between the rows and $1\frac{1}{4}$ feet in the rows and rarely $3\frac{1}{2}$ feet apart both ways.

In another note, particulars of the application of fish manure have been given. When the crop is about two months old, cattle manure is applied at the rate of one head-load to 50 plants. This cattle manure is dark in colour, is well decayed and has a high smell when applied to the land.

The crop is watered daily, generally by pots by hand. The ryots were of opinion that unless the crop were so watered, the drying of the moisture of the dew on the plant would make the leaf bitter or acrid.

To prevent insect pests, 1 *Kudithi* of paddy-husk charcoal mixed with the droppings of sheep is applied to each plant.

One very remarkable feature in the tobacco cultivation of South Canara is the use of a coil made of the grass called *molihullu*, which is yet to be botanically identified, round each plant. The coil is called in Telugu *Moli theerpu*. It is intended primarily to protect the young plant from the sun. On one side the coil is expanded so as to form a broad hood. In the morning the hood of the coil is on the east side of the plant and in the afternoon the coil is turned so as to bring the hood on the west side of the plant in order to shade it.

The coil was observed also to protect the soil moisture from evaporation, in the case of very young crops, as the coil then lay on the soil. When the plant grows taller, the coil is gradually raised on the stem and eventually the function of the coil is reduced to supporting the leaves at the base and preventing them from falling.

When the crop is three months old it is topped. In consequence of this operation the plants put forth suckers. These are removed. The crop is cut when four months old.

One hundred plants when cured fetch Rs. 3 to Rs. 5. An acre generally carries about 9,000 plants. But only ¼ to ½ acre is at the most cultivated by an individual ryot. (C. K. SUBBA RAO.)

∴

FISH MANURE IN MADRAS. At Azhikkal, I was informed by a sea-customs officer and ryots that some of the fish caught at distances of 10 or 15 miles from the shore, sometimes were landed in a semi-decomposed condition, and being unfit for human consumption, were sold for manure at Rs. 25 per ton for application to cocoanut trees. Large quantities of such manure were exported, I was told, to Colombo and Japan from Tellicherry

and Cannanore. It is only in sea-side villages that fish manure is applied to cocoanut trees. The application is said to be attended with a remarkable increase in the production of fruit. The manure is buried near the trees in small heaps.

In a tobacco garden at Kasargod, I saw a canoe or small boat full of a jelly-like liquid. I was told to my surprise on enquiry that it was fish manure prepared by boiling sardines (*Malayalam matti, Canarese bataqi* or baigay) at the rate of one basketful of fish, worth about 2 annas, in 10 gallons of water. There was not the slightest stench. Another kind of fish commonly used as manure for tobacco in Kasargod is what is called in Malayalam, *Ayila*. The jelly prepared out of one basketful of fish is applied to 150 tobacco plants at the rate of 2 cocoanut shellfuls to each plant, the plants being $3\frac{1}{2} \times 1\frac{1}{4}$ feet apart. One basketful of fish manure is thus applied to about 656 square feet.

Fish manure is thus applied when the tobacco crop is one month old, a second time 15 days afterwards, and twice more at intervals of 20 days. About 266 basketfuls of fish manure worth about Rs. 33 are applied to an acre of tobacco crop in Kasargod.

Elsewhere in the Madras Presidency putrid fish is known in a few places to stimulate the production of grapes abundantly.

Fish manure is applied on the West Coast not only to cocoanuts and tobacco but also to cucumber, water melons, and valuable kitchen garden crops. (C. K. SUBBA RAO).

∴

THE NENDRUM PLANTAIN OF THE MADRAS WEST COAST.—This variety occupies large areas in Malabar and produces fruit of very fine flavour. It is especially the well-developed, unripe fruit which is most in demand. The unripe fruit is cut transversely into a number of thin pieces, salted and fried in cocoanut oil. This forms a delicious curry called *Upperi* which is exposed for sale in large quantities in every big village in the district. Even the green rind or peel of the fruit is fried in cocoanut oil and

eaten. The ripe fruit is used for making *payasam* or sweet gruel and various other preparations. The young suckers are also used as food. The roots and outer sheaths are removed from them. They are then shredded into small bits, washed with water and boiled with the addition of salt.

The best conditions for successful cultivation are as under :

Soil.—Red gravelly soil is the best

Season.—Suckers should be planted in the months of *Tula* and *Vrischikam* (November and December).

Preparation of land. The land is generally ploughed twice. Pits one foot cube are then dug about 6 feet apart. On high land manure is applied immediately before planting. On low land, no manure is then applied. To dry land ashes are applied at the rate of one cart-load worth $3\frac{1}{2}$ or 4 rupees for 150 pits. Over the ashes, paddy and stubble called in Malayalam *odoo* is put, and over the stubble the earth removed in digging the pits is so put that there may be a dish-like depression at the top for holding water.

On low or wet land, ashes, paddy, stubble and earth are put in pits one and a half months after planting. On high or dry land, the plantains are watered daily and on wet land every alternate day. In the third month after planting manure is applied for the second time as follows :—

First, a mixture of cattle dung and ashes is applied at the rate of 50 baskets for 100 plants, a basketful of dung costing 8 pies. Over the manure leaves of various kinds of trees, *viz.*, *kavi* (*Acronychia laurifolia*), nux vomica, mango, *pulleni* (*Phyllanthus reticulatus*), etc., are applied, and over the whole, earth is put as before. In the fifth month, a third application of a mixture of dung and ashes overlaid with leaf manure and earth is made as before, the quantity of manure being half as much again. To high or dry land even a fourth application of the same manure is made about two months afterwards. Parallel drains about 6 feet apart, 1 foot wide and $1\frac{1}{2}$ feet deep are opened for draining the land. After each manuring, the land is deeply hoed or hand dug.

Irrigation is generally necessary from January to May In the eighth month bunches are put forth. The fruit is ripe in the eleventh month. Each bunch contains about 25 fruits. A hundred fruits fetch 10 annas to one rupee.

Each tree puts forth on the average 8 suckers. The price of suckers for planting purposes is 1 to 1½ rupees per 100.

The stems of Nendrum plantain are utilized at present for the extraction of fibre. It yields fairly good fibre.

The total money return from the 1,200 and odd trees which occupy an acre is about Rs. 300, of which Rs. 100 covers the expenses and Rs. 100 is paid as rent to the landlord who pays assessment, the net maximum of profit is about Rs. 100 per acre.—(C. K. SUBBA RAO.)

∴

THE VALUE OF INDIAN CATTLE FOR EXPORT.—In the *Orange Judd Farmer*, Mr. T. M. O'Connor has published an interesting account of the value of Indian cattle in Southern Texas. It is claimed for them, among other things, that they are immune from ticks, cross well with local cattle and are very hardy. It is not clear from Mr. O'Connor's account which Indian breed or breeds he refers to, but during the past few years there has been a growing demand for Indian cattle of good class for export. Fairly large numbers of Gujerat and Nellore cattle—cows as well as bulls—have been exported at very remunerative prices to breed work cattle suitable for other tropical and sub tropical countries. The West Indies and South America have indented to a very considerable extent on India for such cattle. Now that a demand for Indian cattle has been established, both in America and other countries, the cattle-breeders in India should do their best to encourage this trade by improving Indian breeds. The high prices paid in recent years for exported cattle must encourage breeders to improve the general character of their stock by better feeding and better management. Thus, somewhat indirectly the general cultivation in India will also be improved by greater tillage power.—(EDITOR.)

SIND EGYPTIAN COTTON. A lecture on this subject was delivered by Professor Shahani of the Sind College, Karachi, at a Meeting of the British Empire League. It is interesting as showing the results obtained by a zamindar cultivating this crop under the ordinary circumstances obtaining in Sind. His yearly yields were as follows:

Year.	Variety.	Area in acres.	Yield per acre.	REMARKS.
1904	Mit-Afifi	4½	1¼ acres at 9½ mds. seed; cotton 3¼ acres at 4¼ mds. seed cotton.	The first portion was sown in March and more or less cultivated after Egyptian methods. Second portion broadcasted on flat without hoeing or thinning.
1905	Mit-Afifi	153	Mit Afifi 7¼ mds. seed cotton. Abassi 6¼ mds. seed cotton.	Water supply deficient; cultivation not so close to Egyptian standard.
,,	Abassi ...	52		
1906	Abassi	505	4 maunds	Bad attack of bollworm.
1907	Abassi ...	275	Average 5 to 6 maunds.	Mit Afifi distinctly more vigorous in growth.
,,	Mit-Afifi ...	300		

These figures present several interesting points which might be summarised as follows:—

I. The closer the approximation to Egyptian cultivation, the better the crop. A number of cultivators simply plough the land once, then sow the seed, give a rough harrowing and irrigate. With treatment like this it is absurd to expect good crops, especially as much of the land is alkali.

II. Mit-Afifi is a more vigorous variety than Abassi. The former did not, however, take well with the buyers on account of its brown colour. So the cultivator got a price below its real value.

III. The yields are poor, and by these figures, hardly as profitable as growing the local Sindhi cotton. The latter would probably average on similar land 12 maunds per acre and be worth from Rs. 5-8-0 to Rs. 6-0-0 per maund of seed cotton. The produce of 1907 Mit-Afifi was graded in Alexandria as above "Fully Good Fair;" the Abassi was not classed. Both were worth at present prices between 8*d.* 9*d.* per lb. Egyptian cotton to pay well should not yield less than 10 maunds per acre.

Professor Shahani's greatest difficulties in the way of cultivation were want of water and labour and bollworm attack; he is, however, hopeful that all these may be overcome.

The conclusion forced on any practical observer is that before the cultivation of Egyptian cotton can be put on a firm basis and extended, the standard of cultivation must be vastly improved. And also the causes which underlie this want of system must be remedied.—(G. S. HENDERSON).

∴

WEST INDIAN AGRICULTURAL CONFERENCE, 1907 (WEST INDIAN BULLETIN, VOL. VIII, NOS. 1 AND 2).—Representatives of the Imperial Department of Agriculture and of the various Island departments met in Jamaica in January 1907 under the presidency of Sir Daniel Morris, Imperial Commissioner of Agriculture for the West Indies. The method of the Conference is, for a comparatively limited and, on the whole, agriculturally homogeneous area like the West Indies, an excellent one. Representatives contributed papers—nearly thirty altogether—showing the lines of work on, and the present position of, the principal agricultural industries of their respective islands. Thus, the Conference at once provides an opportunity for meeting for an exchange of ideas and affords the material for a conspectus of the agricultural position of the West Indies as a whole. The Sugar industry remains the most important in the islands, and it is satisfactory to learn that its prospects have much improved within the last few years. The Sugar Convention has resulted in higher prices being obtained in European markets, and at the same time the Canadian tariff, with its preference for British-grown sugar, has opened up a large new market in Canada, three-fourths of the total production of sugar in the West Indies now finding its way there. Sugar cane diseases, which were such a serious factor in the industry, have been largely brought under control, chiefly by the production of new seedling varieties more immune to disease and, in the case of the best of them, yielding more sugar. The most important need now is said to be the lowering of

the cost of production by improvements in cultivation and manufacture.

Cacao is the second most important industry of the West Indies. Here, again, disease has given a great deal of trouble. Starting with the better varieties, planters have been compelled to abandon them for the low grade hardier sorts, and the quality of the West Indian Cacao on the market has greatly deteriorated. Improvement by seed selection from superior trees is made difficult because of the natural habit of the trees to cross-fertilize. The agricultural departments have, however, shown that improvement can be effected by means of budding and grafting, and they recommend this as a practical method. Recent manurial experiments with Cacao have given gratifying results as regards both yield and resistance to disease. The most successful manure is also the cheapest and most generally available—*viz.*, mulching with grass and leaves.

The annual value of fruit mainly bananas, oranges and grapes, exported from the West Indies, is nearly one million sterling. The great obstacle to expansion of this trade is the difficulty of transport to Europe at reasonable rates. Attention is for the present being concentrated on better methods of handling and packing rather than on the extension of the area under fruit.

Success continues to attend the growing of Sea Island cotton. Introduced experimentally in 1900, by 1906 it occupied an area of 15,000 acres. The yields have been good and the quality of the lint excellent (in 1907 some of the lint fetched as much as thirty pence per pound). The high prices which have ruled for the best qualities of lint owing to shortage in the United States have been mainly responsible for the rapid extension of the area under cotton. Insect pests give a good deal of trouble and are costly to check, and it is pointed out that for this reason and also because unfavourable seasons must be reckoned with, the average of the prices of the last three years must be maintained if the industry is to be established on a firm basis.

In common with other tropical countries, the West Indies is devoting a good deal of attention to the cultivation of rubber

A good many plantations are in existence and such little tapping as has so far been done has given good results. The fact that Estates on which rubber has been planted have risen greatly in value shows that a successful future is anticipated for the rubber industry. The varieties most in favour for planting are Castilloa Para and West African rubber (*Funtumia elastica*), but several other varieties are also being tried.

These are the most important subjects discussed at the Conference. The Agricultural Departments are evidently in close touch with the agricultural problems of the Islands and are doing useful work. It is satisfactory to learn that the existence of the Imperial Department of Agriculture which under the able direction of Sir Daniel Morris has done conspicuously good work has been assured for another term of five years by a grant from the Home Government.—(E. SHEARER.)

∴

LEAFLET NO. 6 OF THE DEPARTMENT OF AGRICULTURE, BURMA. —"INTRODUCTION OF MOULMEIN PADDY INTO THE AKYAB DISTRICT." Some Moulmein paddy seed was introduced by the Government of Burma into the Akyab District last year and was sown by various cultivators in that District. This introduction was successful. The grain produced was better than that from local varieties and the cultivation was sufficient.—(EDITOR.)

∴

THE BENGAL SEED, MANURE AND IMPLEMENTS STORE, 28, POLLOCK STREET, CALCUTTA. As an outcome of many difficulties connected with the supply of good seed to ryots, the Bengal Agricultural Department has opened a Seed Store in the heart of the business centre in Calcutta.

No reliable agency was previously established for the supply to ryots of good seed of the ordinary food grain and garden crops. Mahajans and Banyas usually stock very inferior seed of these crops, because the best seed is either exported or sold locally for consumption each year before seed time. Deterioration of crops

is a natural consequence. It has, in fact, been found that the seed of farm crops obtainable in Bengal from ordinary sources of supply is usually mixed, old, weevilled and poor in germination. Such seed always produces inferior crops.

The seed which is supplied to cultivators from our Store is either grown on the Government Farms or is brought under careful departmental supervision. In this way a beginning has been made towards meeting a long-felt want. The seed which is intended for distribution is sent to the Calcutta Seed Store where it is cleaned, tested for germination and stored in rat-proof bins. These bins are also designed to keep the seed in sound condition.

We supply good seed at ordinary rates, Government bearing all the extra expenses including rent of store, cost of establishment, and other items. More Government seed farms are, however, needed. We also require larger space and better accommodation for storage, as the demands on the Department for good seed are increasing.

Our seed store is intended to demonstrate that a demand for good seed exists. When this demonstration is complete, it is hoped that the good work will be carried on more extensively through private enterprise. The Government Farms will, of course, continue seed improvement and supply improved varieties for experimental and demonstration areas. The millions of tillers of the soil in Bengal, however, require much greater supplies of improved seed than any Government agency can produce.

In other countries (particularly in England and in America) there are seedsmen whose business is to supply farmers with seed which is true to variety and in every way reliable. They strive to improve their seed by cross-breeding and by great care in selection. They use the best grading and cleaning machinery, and they naturally (with advantage to the farmers) compete among themselves to obtain the best possible commercial results.

The Bengal cultivators should be educated to appreciate the value of seed improved in India by the means above referred to

and by other means. The ordinary ryot will not at present pay the higher prices which are necessary to make a "Seedsmen business" pay its way. He may be educated up to this standard in time. The chief demand for seed from the Bengal Seed Store comes at present from big Zamindars.

It may be noticed casually that hardly a century ago English farmers were mostly ignorant of what science could do for them. During a period of some 20 years early in the 19th century great progress was made and has been continued. We possibly may look in time for a similar record of progress in Bengal in seed growing and in other agricultural improvements.

The following statement shows the quantity of each kind of seed distributed from the Bengal Seed Store in 1907 :—

		Mds.
C. P. Aus Paddy		91½
Bengal Aus Paddy		3
Aman Paddy	Mds.	
Badshabhog	12½	
Banktulshi	½	
Samudrabali	17½	
Dadkhani	12	
Khirajira	1	
Chingriddhusha	1	47
Katarribhog	½	
Sukavel	[illegible]	
Kanchanchira	1	
Mahurapwa	1	
Katanghai	½	
Kamode	½	
Jaunpur Maize		37
Juar		37
Groundnut		40½
Wheat		66½
Barley		27¼
Oats		25¼
Mustard		32¼
Cotton Seed		
Buri Kapas		21
Dharwar American		10
Dhamcha		20
Jute		266

POTATOES.	Mds.
Patna and Naini Tal	261
Madrasi	4
Kalimpong	67½
Irish	27
	1,073¾

SUGARCANE.	
Shamsara	2,380 cuttings.
Khari	6,820 "
Ikri	1,20,000 "
Khagir	8,000 "
Mauritius	5,000 "
	Mds.
Buck Wheat	3

VEGETABLES.

China cabbage	Some seed of each of the varieties was supplied
Onion seed ...	
Beet	
Egg plant	
Turnip	
Soja Bean, etc.	

In all 1,083¾ maunds or 88,554 pounds were distributed including sugar-cane cuttings.

The largest distribution of seed of any one variety of crop was 266 maunds of jute seed which was only sufficient for a very small proportion of the area actually sown. Other seeds distributed had still less effect on total areas. The inference is that a vast field exists for private enterprise in supplying reliable seed to cultivators.

In a series of experiments lasting over several years, the following varieties of crops have proved their superiority over others and are recommended for cultivation :—

Paddy	Aus Central Provinces, fine. Aman Dadkhani, Banktulsi, Badshahbhog, Samudrabali and Balam.
Jute	Deswal, Hewti, Kakya bombai.
Sugar-cane	Khari for ordinary cultivators. Stands drought and water logging, is prolific, not damaged much by white-ants, jackals and pigs and gives a good sample of gur.

Ikri	for excessive water-logging.
Maize	Jaunpur
Juar	Sarun
Rahar	Sarun
Wheat	Muzaffernaggar white.
Oats	Dumraon.
Mustard	Raipur and Jubbulpore
Gram	Patna.
Groundnut ...	Cuttack.
Potatoes	Patna and Naini Tal.

Good and tested seed of the above-named varieties is stocked in the Bengal Seed Store. Intending purchasers should send in their indents for Jute and Aus Paddy in January; for Maize, Rahar, Aman Paddy and Groundnut in March; for Wheat, Oats, Gram, Mustard and Potatoes in August, and for Sugar-cane in November.

Besides seeds, we store a few manures for the use of cultivators who may obtain small quantities at the lowest market rates. In 1907, we distributed :

	Mds.
Bonemeal	265¾
Superphosphate	165
Sulphate of Ammonia	23
Kainite	9½
Saltpetre	218¾
Castor cake	65½
Safflower cake	5

A few implements of patterns likely to suit India are also stocked in our Depôt.

The net cost to Government of running our Seed Store for 1907 was rent Rs. 2,400, and establishment Rs. 1,362, or a total of Rs. 3,762.—(F. SMITH.)

RATIN. References to this preparation for the extermination of rats will be found in this Journal, Vol. II, Part 3, and Vol. III, Part 1. It has recently received a thorough trial in Behar at the instance of the Inspector-General of Agriculture. Experiments on caged rats were tried at the Sirseah Research Station and 10 tins were distributed amongst planters in the district for practical trial on both house and field rats.

Two classes of "Ratin" are prepared by the makers known respectively as No. I and No. II. The latter is said to be the more virulent and also to keep the better, but is the more expensive. Both kinds were tried within the period for which the keeping qualities of the preparations were guaranteed, but, in order to make sure of the vitality of the cultures, a tin of each batch was opened and tested bacteriologically at Sirseah. Evidence was obtained that both preparations contained living bacteria.

Two healthy house-rats were caught in traps and fed on No. I and No. II "Ratin" respectively. After they had eaten about a tablespoonful each, they were let loose amongst healthy rats in cages. The rat which had eaten No. I did not seem any the worse for it, nor did he infect his cage companions within three weeks. The one which received No. II died within 48 hours, but also produced no infection amongst the other rats within three weeks. Similar experiments with field-rats were tried with No. II only, and again with negative results; no effect seemed to be produced either on the rat which actually ate the "Ratin" or on his cage companions within three weeks.

It is difficult to draw a definite conclusion from the practical trials which were carried out at Sirseah and elsewhere in Behar. "Ratin" No. I was put down in rat-infected godowns at Sirseah and a number of the baits were taken, but no dead rats have been found, and the only evidence we have indicating that some effect may have been produced is that, whereas formerly rats could be trapped in these godowns daily with practical certainty, it is now only rarely that a rat can be caught.

Four out of ten planters to whom the preparation was sent, report similarly that since its application few or no rats have been seen in places which were previously infested, but no dead bodies have been found. The absence of dead rats is not necessarily an indication that the application has been ineffective, since it is, we believe, claimed by the makers that the rats frequently migrate to die.

Four planters report that absolutely no result has ensued from the application, and the remainder failed to carry out the trials.

It would seem, therefore, that "Ratin" does not act as effectually in India (or at any rate in Behar), as it is said to have done elsewhere, but the results obtained in one or two cases are perhaps sufficiently encouraging to justify a repetition of the trials. (C. BERGTHEIL.)

.·.

RECLAMATION OF LAKE ABOUKIR. It is now 21 years ago that the concession of Lake Aboukir, one of the smallest of the great lakes in North Egypt, was obtained from the Egyptian Government. At that time it was an absolute barren tract of about 30,000 acres, dry in summer but covered in winter with sea water a few inches deep.

The work of reclaiming the lake was started by digging the main canal and drains. Large centrifugal pumps were erected in order to pump out the salt water into the sea. This work was found to be very exhausting on the Company's resources, and prospects were at first not bright. Criticism and advice were freely offered by the general public. The Lake was said to be pure sand and the owners were advised to practise colmatage or silt deposition till the lands would drain into the sea or to grow salt-bush and similar plants. Either idea would have taken some 200 years to produce the desired effect.

The outlook, however, from the time the Government allowed a gravitation outlet for drainage into Lake Mareotis, continued to brighten, and owing to the increased demand for Egyptian cotton, prices of land rose steadily. The Company's system of washing and drainage proved a thorough success, and the sale of some of the reclaimed lands soon put it on a firm basis.

Since then, nearly £315,000 have been paid in dividends and debenture interest, *i.e.*, about twice the capital invested. There still remains to the Company about half their land which is now nearly all reclaimed. Most of it is let to native tenants at a yearly rent varying from £5 to £8 per acre.

On Aboukir it is not "two blades of grass where one grew before," but the creation of some 50 square miles of fertile land out of a barren waste now supporting a population of about

12,000. Not only has this wealth gone into the pockets of share-holders, but labourers, tenants, and purchasers have all benefited. Government also now draw a rapidly increasing sum in land tax.—(G. S. HENDERSON.)

GLUCOSODE PROCESS OF INDIGO MANUFACTURE.—The Glucosode process was worked during the season 1907 at the head factory of the Turcouleah Concern, Chumparan, for the whole of "Moorhun" manufacture. No side by side comparative trials were made (these were made in 1906), but it was decided to compare the total results of a season's manufacture with the working of the ordinary process at the neighbouring factories of the same concern, soil and other conditions being similar.

A total of 62,478 maunds of green plant was worked off by this new process of manufacture. The outturn was 271 maunds of indigo, representing a produce of $17\frac{4}{16}$ seers per 100 maunds of plant. The ordinary manufacturing process was worked during "Khoontee Mahai" to the extent of 9,715 maunds of green plant, the outturn from this being 23 maunds and 25 seers of indigo, representing a produce of $9\frac{12}{16}$ seers per 100 maunds of plant. The ordinary outturn of Turcouleah factory in 1906 was $9\frac{11}{16}$ seers aganist an average of $11\frac{9}{16}$ seers at Muckwah and $10\frac{13}{16}$ seers at Ghyree, these two being the neighbouring factories, with the outturn of which the results of the new process will be compared, the produce there being on the average 15 to 20 per cent. better than at Turcouleah. The average produce at these two factories in 1907 by the ordinary process was for Muckwah $11\frac{10}{16}$ seers of indigo per 100 maunds of plant, and for Ghyree $10\frac{14}{16}$ seers.

If the ordinary process had been worked at Turcouleah, an outturn of $9\frac{12}{16}$ seers of indigo per 100 maunds of plant could, therefore, have been expected, which estimate is confirmed by the fact that this was precisely the outturn during "Khoontee Mahai." The Glucosode process yielded $17\frac{4}{16}$ seers of indigo per 100 maunds of plant, being an *increase of 76 per cent.*, or a gain of 117 maunds of indigo of what was manufactured.

The proportion of Java-Natal indigo manufactured was at Turcouleah 26·2%, at Muckwah 32·8%, at Ghyree 23·6%, per cent., the rest being Sumatrana indigo.

The indigo manufactured by the new process was sent to Calcutta in two batches: the first batch was valued by the indigo brokers at Rs. 147-8-0 per maund all round and was shipped to London to be sold there; the second and slightly inferior batch was valued all round at Rs. 145, and was sold in Calcutta for Rs. 146-8-0 per maund.

The cost of the process has been worked out by the Manager at Rs. 25-12-0 per steeping vat of 2,000 cubic feet capacity: 194$\frac{1}{2}$ such vats were worked with the process, making the total cost of producing 271 maunds of indigo—Rs 4,008.

We must, however, add to this some extra manufacturing charges, also the freight and commission on the plus production of 117 maunds of indigo, and the royalty on 271 maunds, altogether about Rs 1,310.

The quality was not so good as was turned out by the same process at Burhurwah factory in the same concern in 1906, by reason of our not having had at Turcouleah sufficient boiler room for the purification of the fecula. The Managing Proprietor of Turcouleah concern estimates that if the ordinary process had been worked, the indigo would have sold at Rs. 10 per maund better all round.

We have, therefore, to deduct from the profit made a sum of Rs. 2,710, representing the deficiency in quality.

The account of profit stands as follows:—

	Rs.	Rs.
Increase by the Glucoside Process 117 maunds of Indigo, at Rs. 145 per maund		16,965
Deduct, cost of Process as stated by Manager ...	4,008	
Extra charges and royalty	1,310	
Loss in quality	2,710	
Total ...		8,028
Total net profit ...		8,937

	Rs.
Net profit by this new Process per 100 maunds of green plant	= 14-5-0
Net profit by this new Process per 1,000 cubic feet steeping vat	= 23-0-0

(EUGENE C. SCHROTTKY.)

I have pleasure in publishing in our Journal the above Note by Mr. Schrottky. I will have equal pleasure in publishing any criticisms which may be offered by Indigo Planters or by others who are interested in this enquiry. (EDITOR.)

*
* *

EAR COCKLE—A WHEAT DISEASE.—A Wheat disease, Ear Cockle (*Tylenchus Scandens*), not previously reported in India so far as is known, has been recently discovered in the Punjab, and on at least an area of several acres has destroyed about $\frac{3}{4}$ of the crop.

At harvest, infected crops look quite healthy to anyone passing even closely past them, but brown galls are found in place of the wheat grains and are about $\frac{1}{3}$ to $\frac{1}{6}$ of the size of these. The galls are infested by minute worms.

Investigations up to date have disclosed that there are traces of the disease in many districts in the Punjab, and evidence points to the probability that it may be found over a still wider area, but that it only does excessive damage in specially favourable conditions.

Further investigations are in progress to obtain, if possible, some idea of the area affected and of the damage which is usually done.—(D. MILNE.)

REVIEWS.

THIRD ANNUAL REPORT OF THE BRITISH COTTON GROWING ASSOCIATION FOR THE SIXTEEN MONTHS ENDING 31ST DECEMBER 1907. (Manchester, 1908.)

ACCORDING to this Report, the total amount of shares subscribed for on 31st December 1907 amounted to £260,632. In order to raise further capital, the British Cotton Ginning Company, Limited, was formed, with a capital of £100,000, all of which has been subscribed. The Association also holds £60,000 worth of shares in the British East Africa Corporation and £30,000 in the Rhodesia Company, making a total capital of £450,000. The annual turnover in cotton alone now amounts to nearly £250,000. A large business is growing up in marketing and insuring cotton, supplying stores, machinery, etc., for planters and others, on which the Association earns a commission. From this it will be seen that the work of the Association has grown considerably.

The Council of the Association have to report that the experiments carried out in India through the medium of Messrs. Shaw, Wallace & Co., of Calcutta, with "Tree" and other cottons have failed. A small quantity of cotton has been produced, and possibly there may be some further return, but in view of the doubtful possibility of this occurring, the whole of the money spent was written off in last year's account. Similar experiments in India have been carried on by Mr. Spence, with Tree cottons. It is understood that these have been rather more successful, but the Association have been unable to take an active part in the same.

The cultivation of Egyptian cotton has been continued in Sind with fairly satisfactory results. The acreage planted and the approximate yield are as follows :—

	Acres.	Yield.
1905	1,000	450 Bales of 400 lbs.
1906	5,000	700 ,, ,,
1907	6,000	1,800 ,, ,,

An improvement has been made in the system of marketing, and the native growers have received better prices than in the past, but there will be great difficulty in establishing the cultivation of exotic cotton, which requires more care and attention than native varieties. The Association does not think it can do much in this direction, but with the aid of the Government of India it hopes that even if it is impossible to extend the cultivation of Egyptian cotton in Sind, the supply of improved and selected strains of indigenous seed may be able to effect an improvement in Indian cotton, not only in Sind, but throughout the whole of India. The largest tracts of land under cotton at the present moment are in India, and if it were only possible to improve the quality of Indian cotton, Lancashire's dependence on the vagaries of the weather in the United States would become a thing of the past.

In Ceylon the cultivation of long-stapled cotton continues to make progress, and the Association is now arranging for the erection of a small ginning plant in that colony.

In the West Indies important developments appear to have occurred, and the progress recorded in the last report has been surpassed in 1907. Larger quantities of cotton have been grown and have been sold at high prices, and the industry is now established on a permanent basis, so that the West Indies can confidently be looked to for a sufficient supply of the best long stapled cotton to render England almost independent of the United States.

In West Africa, too, considerable progress has been made, and the report goes so far as to say that the Association is "now convinced that Lancashire can confidently look to West Africa

as the great cotton producing field of the future." From Lagos alone, 1,050 bales were shipped in one steamer in May 1907. Grants-in-aid are provided by the Government towards which the Association has to subscribe similar amounts. The progress made in this part of the country is interesting, and the following statistics of the value of cotton and seed exported from this colony during the last few years will show this.

	£
1902	200
1903	7,000
1904	12,000
1905	28,000
1906	60,000
1907	100,000

Efforts are likewise being made to establish cotton growing in Sierra Leone, the Gold Coast, North and South Nigeria, Nyassaland, Uganda, Rhodesia, and South Africa, and assistance is being rendered by the Association in Queensland with the same object. So that, on the whole, the Association is to be congratulated on the material progress it has made towards rescuing the Lancashire cotton industry from the thraldom of the United States. (BERNARD COVENTRY.)

∴

STUDY OF THE VALUE OF CYANAMIDE OF CALCIUM AS A NITROGENOUS MANURE. BY A. MUNTZ, MEMBRE DE L'INSTITUT, DIRECTEUR DES LABORATOIRES DE L'INSTITUT NATIONALE AGRONOMIQUE, AND BY P. NOTTIN, INGENIEUR-AGRONOME. (*Annales de l'Institut Nationale Agronomique.* 2^e Serie. Tome VI. Paris, 1907.)

ANY fresh information which can be given regarding the problem of the future supplies of nitrogen for agricultural purposes must be of importance to any one interested in safeguarding and improving the agriculture of any country, and the recent experiments of Muntz and Nottin in France on cyanamide of calcium appear to call for some notice. In the article quoted above the authors give a complete account of its history, describe

its nature, and record a series of both laboratory and field tests, which are well worth the perusal of the student of agriculture.

As pointed out by them, agriculture and the industries consume nitrogen in quantities that are steadily increasing, while the known supplies of combined nitrogen existing in animals, vegetables or fossils, are very restricted. This has led to attempts to utilize the resources of atmospheric nitrogen by combining it with other substances. The fixation of free nitrogen is brought about in nature by the action of bacteria in the soil and at the roots of leguminous crops, but the process of formation is slow, and the nitrogen formed is mixed with a large volume of earth and does not lend itself to easy extraction. The fixation of nitrogen by chemical means gave but poor results until more recent investigations opened out prospects in two directions. One based on the researches of Cavendish and worked out in practice by Birkeland and Eyde, has resulted in the formation of calcium nitrate by the use of atmospheric nitrogen and was for the first time carried out in Norway. The other was based principally on the combination of free nitrogen, with metals and the carbides of metals. Margueritte and de Sourdeval had obtained cyanide of barium by passing nitrogen over a mixture of carbon and baryta at a high temperature. From this it was discovered that nitrogen is taken up by the carbides of the metals and by metals such as magnesium and calcium, and Maquenne, in 1892, combined nitrogen with the alkaline earths at a red heat. These reactions, however, were only useful from the point of view of laboratory work. They were different from the means of fixing nitrogen discovered by Frank of Charlottenburg and by Caro. These experts endeavoured to apply the discoveries of Margueritte and de Sourdeval to the manufacture of cyanide. They tried the action of atmospheric nitrogen deprived of its oxygen, on carbide of calcium, a commercial product, but the reaction was different from that which they expected, and cyanamide of calcium and carbon were formed.

$$CaC_2 + 2N = CN_2Ca + C.$$

Cyanamide of calcium was not a new product, for it had already been formed in the laboratory. The Society "Cyanid Gesellschaft" had made cyanamide of calcium in an experimental factory at Berlin. The results of these investigations were satisfactory, and in 1906 one factory was started at Piani d'Orte in Italy, and two were under construction at Sebenico in Dalmatia and Notre-Dame de Briançon at Isère.

It is thus that nitrogen drawn from the air and fixed by the carbide of calcium as cyanamide has come into use for agricultural purposes, and it is from this point of view that the product has been studied in this article.

The following is a description of its manufacture. Carbide of calcium in a fine state of subdivision is placed in retorts resembling those used for gas making and brought to a white heat. A current of nitrogen is passed over the carbide of calcium which is then almost entirely converted into cyanamide. The nitrogen is obtained by first passing air over copper filings brought to a red heat, by which the oxygen is abstracted, and the oxide of copper is again reduced by passing over it tar spirit, and thus making the copper indefinitely available.

Crude cyanamide of calcium is very impure, some of the carbide having remained unchanged. This is got rid of by crushing it up and allowing it to remain exposed in a humid atmosphere, when it is converted into acetylene and lime. The commercial product contains only 20 to 22 per cent. of nitrogen, while the pure product, CN_2Ca, contains 35 per cent. The authors then proceed to describe some of its properties, and experiments made in the laboratory. They find that cyanamide of calcium is easily changed into ammonia and that, as shown by S. F. Ashby,* under the action of soil microbes, this is effected with a certain degree of rapidity. The researches of Gerlach and Wagner† on Sugar Beets which commenced in 1901, show that nitrate of soda, sulphate of ammonia and

* *Journal of Agricultural Science*, 1905. I, 358.

† *Landw. Presse*, 11th July 1903.

cyanamide give the same results, and Strohmer,* Schulze,† and Hall‡ admit that the new manure is equal to nitrate of soda and sulphate of ammonia. Afterwards Grandeau§ and the "Societa Italiana per la fabricazione di prodetti azotati per l' agricultura" in 1906, came to the same conclusions. But there would appear to be an exception to this, as shown by Perotti|| and other workers, that where cyanamide is applied in excess, as for example corresponding to 750 kilos of sulphate of ammonia per hectare, the germination of seed was checked and in some cases plants were killed. To overcome this difficulty, it is suggested by some that the manure should be applied some time before sowing, from which it may be inferred that the cyanamide is not used by plants till after its conversion in the soil.

In order to determine the order in which the plants absorb nitrogenous manures, Roszler¶ made series of pot-cultures, in which he determined the quantity of nitrogen absorbed by the various manures every ten days. He found that during the first 28 days, the absorption of nitrogen from cyanamide was *nil*, while that of nitrate of soda was 40·3 per cent. and sulphate of ammonia 48·40 per cent. This to a certain extent explains the contradictory results obtained by the application of cyanamide in large quantities.

The authors then explain their own experiments to determine the agricultural value of cyanamide and especially their study of its transformation into nitrate, under which form it is almost exclusively taken up by plants. They find that if cyanamide is used in moderate doses, then nitrification is as complete and rapid as with sulphate of ammonia, and that quantities, such as would correspond to a full dose of manure, can with every

---

* *Osterr. Ungar. Zeitsch. f. Zuckerind. und Landw.*, 1906.

† *Jahresber. d. Versuchsst. Breslau*, 1904-5-8.

‡ *The Journal of Agricultural Science*, I, Jany., 1905.

§ *Journal d'Agriculture Pratique*, 1906, I, p. 8.

|| *Staz. sperim. Agrar.* Ital. 1904, 38, 881.

¶ *Ill. Landw. Zeit.* 1905, 25, 311.

advantage be applied, provided this is done in a small dose at a time, otherwise large applications at a time tend to paralyse the action of the nitrifying organisms of the soil. It must, therefore, be used with prudence. They then enquired into the action of the caustic lime which accompanies the cyanamide, and their experiments proved that any retarding effect was due to the action of the cyanamide itself rather than to the lime, and that soils rich in organic matter can advantageously take up more of the manure than soil deficient in this constituent. They conclude that it has a toxic effect on the organisms of the soil when used in excessive quantity, but that this is reduced to a negligible quantity if it is used in moderate doses.

The question of possible loss of nitrogen in the storage of cyanamide was investigated. They found that, kept in sacks and stored in a dry place, there occurred hardly any loss, and that such losses as have been supposed to have taken place by some, have been greatly exaggerated. They also considered the effect of mixing other manures with cyanamide and found that when mixed with kainit there was no loss of nitrogen at all even after 12 days. With superphosphate it was otherwise, and a loss of 5 per cent. was discovered. It would, therefore, seem necessary to avoid making a mixture with this manure. They further recommended that before application, cyanamide should be mixed with an equal quantity of damp earth or be slightly watered, so as to reduce it to the consistency of superphosphate, and they say that, if applied in this way, there will be no loss of nitrogen, any ammonia given off being retained by the water. Their laboratory experiments then indicated that cyanamide was a nitrogenous manure analogous to sulphate of ammonia, but it became necessary to verify this by a series of field experiments, and in order to show also that it had no pernicious effect on plants. With this object they planned comparative experiments in various parts of the country with crops such as wheat, oats, mangels, sugar beets, potatoes, maize, pasture, fodder crops and vines. For details of this work I must refer the reader to the original article, but the following mean results obtained with wheat and

oats and reduced to weight per hectare afford fair examples of the deductions obtainable from the use of the manure.

Wheat.

	Cyanamide applied before sowing.	Cyanamide applied with the seed.	Sulphate of Ammonia.	Test Plot.
	Quintals.	Quintals.	Quintals.	Quintals.
Total weight	92	97	88	83
Grain	30	33	28	27
Straw ...	57	56	51	48

Oats.

	Cyanamide applied before sowing.	Cyanamide applied with the seed.	Sulphate of Ammonia.	Test Plot.
	Quintals.	Quintals.	Quintals.	Quintals.
Total weight	93	93	95	84
Grain...	33	32	33	30
Straw... ...	56	55	56	47

The conclusions to be drawn amount to this, that cyanamide applied before or at sowing time, gives the same results as sulphate of ammonia. And, further, the field experiments demonstrate that cyanamide does not affect germination, if the quantities usually applied for agricultural purposes are used. It has given good results with an application of 200 kilos per hectare, the quantity which may be considered normal.

It would thus appear that cyanamide may be considered equivalent to sulphate of ammonia and that it may be substituted for this manure and applied in the same manner. (BERNARD COVENTRY.)

***

FARM LIVE STOCK OF GREAT BRITAIN. BY ROBERT WALLACE. Fourth Edition, pp. 758 and 214 Plates. Published by Oliver and Boyd, Edinburgh. Price 14s.

PROFESSOR WALLACE's book on the Farm Live Stock of Great Britain has long been recognised as the standard work on the

subject. The present edition which has been entirely re-written and more than doubled in size, brings the account of the previous editions thoroughly up to date. The history and present position of the British breeds of Farm Live Stock are exhaustively dealt with, and the general management of live stock in health and disease is treated in a manner which will commend the book to all practical men. For the numerous photographic illustrations which in this, as in the previous editions, are a great feature of the book, we have nothing but praise. Great care has been taken in placing the animals so as best to show the characteristic points, and the beautiful half-tone reproductions reflect great credit on the publishers. We congratulate the author on the great advance achieved in this edition which, we are confident, will enjoy a wide circulation among all those interested in the art of breeding.

Great Britain has led the world in the improvement of all classes of live stock, and hence a study of the history of breeding and of the results achieved there is instructive. What strikes one most forcibly at the start is the extraordinary number of breeds of cattle, sheep and horses found in such a comparatively limited area, notwithstanding that in the general improvement of stock during the last century several breeds have entirely disappeared. To take cattle alone, Professor Wallace describes at least sixteen distinct breeds, each occupying a position in the agricultural economy which apparently at present cannot, with the same advantage, be occupied by any other. Thus, for a time the old long horn breed was threatened with being crossed out of existence by the more popular short horn, but it was realised, before it was too late, that the long horn was peculiarly suited to certain agricultural and climatic conditions, and now it is to some extent re-establishing its former position. The truth is that the various breeds have been largely shaped by, and become adapted to, the environment in which they have been produced, and hence, unless the conditions which have given rise to a particular breed have materially changed, the greatest caution must be exercised in attempting to replace it by another

whether by complete substitution or by crossing. This is a fact which has not always in the past been appreciated in India and which goes far to explain the numerous failures that have attended attempted short cuts to cattle improvement by ill-advised crossing.

The last century has witnessed a remarkable improvement in British breeds of cattle—an improvement effected for the most part by judicious mating and systematic and rigorous selection within each breed. The power which lies in the hands of the breeder to mould a breed to a particular type, whether as regards form or as regards certain qualities, is little short of marvellous. It is a noteworthy fact that, in the case of the breeds which have come most to the front, a very few men have been, at any rate in the initial stages, mainly responsible for the improvement. These have been men of rare judgment and foresight who, having in their mind's eye a particular type as the goal to be aimed at, have kept that steadily in view, until after years of patient effort they have achieved the desired result.

The advantages which have accrued to British agriculture from the improvement effected in its cattle are incalculable. Producers and owners of the best strains have benefited from the very high prices commanded by their stock. With the dissemination of the latter and the influence which they have had in raising the standard of stock all over the country, the farming community at large has greatly benefited, in that they have had put into their hands a better and more economical class of stock—stock that for the same feeding and attention yield a much higher return than formerly. The demand from all parts of the world for well-bred stock has been and is enormous. In recent years, indeed, and largely as a result of this foreign demand, no branch of farming has paid so well as the rearing of good pedigree stock.

In India the better breeds of cattle are proof of what can be achieved by careful breeding. Superior specimens of the Gujerati work bullock, for example, would be hard to beat in any country for the combined qualities of shapeliness, strength, speed

docility and endurance. Or, again, to take milk breeds, Montgomery and Sindi cows compare not so very unfavourably with European standards. On the other hand, there are very large tracts, usually where the cultivation is of an intensive character, in which cattle-breeding has received the scantiest of attention. As a rule, India's better breeds have been produced in arid, slightly cultivated tracts by nomad tribes, whose herds of cattle have constituted their main property and means of subsistence, and who have made it a special care to, as far as possible, breed from superior specimens. In recent years various causes have contributed to diminish the supply of good cattle available from the professional breeders. In some cases famine has wrought terrible havoc in their herds, in other cases the extension of cultivation made possible by canal irrigation has contracted the grazing areas and has converted the professional breeder into an agriculturist, whose main interest it is to raise good crops rather than to rear good cattle. The problem in India, therefore, is not only to improve the many inferior breeds but to maintain and, if possible, raise the standard already attained in the case of those superior breeds. It is a very much more difficult one in India, a country of small cultivators and small resources, than in England. Here we cannot expect to find private individuals with the necessary breadth of outlook and the necessary capital and patience to leave their impress on any breed. The peculiar conditions of India and the magnitude of the interests involved, make Government assistance desirable or imperative, at any rate, in many cases, and this fact has already been recognised in several provinces. Where Government assistance is provided, the first duty of those entrusted with the task of cattle improvement in any tract is a very careful study of the agricultural and economic conditions with a view to determining the type which is required and which, taking all the circumstances into view, will be suitable for that tract. This may appear to be a truism, but in the past there have not been wanting mistakes which show the great necessity of laying down a sound policy in the beginning—a policy

which, once adopted, can be adhered to. It must never be forgotten that a breed may be good in itself and yet wholly unsuited to the tract in which it is intended to be introduced. The required type having been determined, the practical measures taken to establish it will consist in breeding bulls of that type for distribution and in encouraging that class of animal by prizes at cattle shows and in every other way possible.

The provision of adequate grazing and fodder supplies is the crux of the whole question of cattle improvement. Without this provision there can be no sound basis on which to work. As in the past, we shall have to look for our very best cattle to those regions where there are extensive areas of waste land. There are large tracts which can never be capable of cultivation, and in the interests of agriculture these should be thrown open to grazing as far as is necessary. Such tracts may not show such a large direct revenue, as they would under protected forest, but the indirect benefits to the agricultural community would more than compensate. On the other hand, we cannot hope to reserve indefinitely, as grazing areas, lands which will give a substantially higher return under the plough. Past experience has repeatedly demonstrated the necessity of providing reserves of fodder if our better breeds are not to be decimated in times of prolonged drought. How exactly this is to be done is very difficult to say. It obviously involves large questions of organization, and the means employed will probably vary in different localities.

In the more highly cultivated tracts where the agricultural population is large and the holdings small, the problem of an adequate food-supply is still more difficult. The village wastes are, as a rule, incapable of supporting any large number of cattle, and too often they have been encroached on by cultivation to an extent which should never have been allowed, for, apart from the grazing which they afford, they are of value in providing that free run outside which is essential if cattle, and especially young stock, are to thrive properly. In such tracts the major portion of the food must be supplied from whatever is available

from the cultivated fields. At present the quantity so provided too often constitutes little beyond a starvation ration, yet presumably the cultivator gives his cattle as much as he can afford. If that be so, he can only afford to increase his fodder crops or to purchase additional feeding stuffs, provided he has put into his hands a more efficient animal—an animal which will give him a bigger return for a given quantity of food. What the small cultivator requires is a good general purpose cow—a cow that will give a fair yield of milk, which will help so far to cover the cost of her keep, and that at the same time will produce good stock for work purposes.

The most encouraging feature with regard to cattle improvement in India is the steadily increasing demand for really good cattle—both work bullocks and milch cows. Within the last few years prices for the best classes of stock have risen fifty per cent. or more, and with average agricultural prosperity there is every probability of these higher prices being maintained or still further enhanced. Already, too, a demand from abroad has set in, and this is capable of indefinite expansion, provided good stock can be produced in sufficient quantity. The prospects for breeders have never been brighter, and we trust that this fact, combined with the assistance which is being given by Government in various provinces, will give such a stimulus to cattle improvement all over India as will bear fruit in the near future. (E. SHEARER.)

.˙.

STUDIES IN THE EXPERIMENTAL BREEDING OF THE INDIAN COTTONS. AN INTRODUCTORY NOTE. BY H. MARTIN LEAKE, M.A.

THIS interesting Note on the Breeding of Indian Cottons by the Economic Botanist to the United Provinces appears in the Journal and Proceedings of the Asiatic Society, Vol. IV, No. 1, 1908. It shows very careful and precise observations on the part of the author and is a good example of the accurate research work which is so much needed in this country. The experiments have

reference to six species of Indian cottons given by Gammie in his "Indian Cottons."* They are :—

Gossypium arboreum, Linn.	*Gossypium indicum*, Lamk.
" *herbaceum*, Linn.	" *neglectum*, Tod.
" *intermedium*, Tod	" *cernuum*, Tod.

The above species, the author informs us, form a definite group, the members of which, when crossed *inter se*, are completely fertile. They afford a range of variation which, added to the readiness with which the flowers may be handled and the duration of the flowering period, gives most suitable material for a study in plant-breeding. By far the most interesting portion of the author's work is that in which he has apparently established an accurate factor for the determination of "species" and "varieties" based on the measurement of certain portions of the leaf. The determination of this factor was the result of numerous measurements, numbering over 10,000, and the plants for which this factor has been determined, number considerably over one thousand, and the limiting values have been found to be 0·8 and 5·1. Plants for which this factor bears a value between 0·8 and 2·1 are classified as bearing palmatifid—or 'broad'-lobed—leaves, while plants for which this factor bears a value of 3·0 or over are classified as being palmatisect—or 'narrow'-lobed—leaves. If, now, a plant of which the leaf-factor is less than 2·1 be crossed with a plant of which the leaf-bearing factor is greater than 3·0, it is found that the leaf-factor of the offspring in the first generation approximates remarkably to the arithmetic mean of the two parental leaf-factors, and he has proved by a large number of experiments that this leaf-factor with one exception proved to be a constant character for a particular plant.

The author further appears to establish the fact from careful observation that cross-fertilization of cottons under natural conditions is of common occurrence and states that this phenom-

* The Indian Cottons, by G. A. Gammie, F.L.S., Professor of Botany, College of Science, Poona. Printed at the Government Central Press, Calcutta, 1905.

menon requires to be emphasized in view of the fact that it has recently been denied. It is impossible at present to state with certainty to what extent cross-fertilization takes place, but the evidence so far obtained indicates that natural crossing occurs with sufficient frequency to render it impossible to keep types pure when they are grown in the proximity of other types.

For further details of these investigations the reader is referred to the author's Note. (BERNARD COVENTRY.)

NOTICE.

THE Memoirs of the Department of Agriculture in India, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

BOTANICAL SERIES.

Vol. I, No. I. The Haustorium of the Santalum Album—Early Stages by C. A. BARBER, M.A., F.L.S. Price, Re. 1.

Part II. Cases of Irregular Penetration by C. A. BARBER, M.A., F.L.S. Price, Rs. 3.

Vol. I, No. II. Indian Wheat Rusts by E. J. BUTLER, M.B., F.L.S. and J. M. Hayman. Price, Rs. 3.

Vol. I, No. III Fungus Diseases of Sugarcane in Bengal by E. J. BUTLER, M.B., F.L.S. Price, Rs. 3.

Vol. I, No. IV. Gossypium obtusifolium, Roxburgh, by I. H. BURKILL, M.A. Price, Re. 1.

Vol. I, No. V. An Account of the Genus Pythium and some Chytridiaceæ by E. J. BUTLER, M.B., F.L.S. Price, Rs. 4-8.

Vol. I, No. VI. Cephaleuros virescens, Kunze: The Red Rust of Tea by HAROLD H. MANN, B.Sc., and C. M. HUTCHINSON, B.A. Price, Rs. 4.

Vol. II, No. I. Some Diseases of Cereals caused by Sclerospora Graminicola by E. J. BUTLER, M.B., F.L.S. Price, Re. 1-8.

Vol. II, No. II. The Indian Cottons by G. A. GAMMIE, F.L.S. Price, Rs. 7-8.

Vol. II, No. III. Note on a Toxic Substance excreted by the Roots of Plants by F. FLETCHER, M.A., B.Sc. Price, Re. 1-8.

Vol. II, No. IV. The Haustorium of Olax Scandens by C. A. BARBER, M.A., F.L.S. Price, Rs. 2-8.

Vol. II, No. V. The Haustorium of Cansjera Rheedii by C. A. BARBER, M.A., F.L.S. (*In the press.*)

CHEMICAL SERIES.

Vol. I, No. I. The Composition of Indian Rain and Dew by J. W. LEATHER, Ph.D., F.C.S. Price, Re. 1.

Vol. I, No. II. The Composition of Oil Seeds by J. W. LEATHER, Ph.D., F.C.S. Price, Re. 1.

Vol. I, No. III. The Pot-Culture House at the Agricultural Research Institute, Pusa, by J. W. LEATHER, Ph.D., F.C.S. Price, Rs. 3.

Vol. I, No. IV. Experiments on the availability of Phosphates and Potash in Soils by J. W. LEATHER, Ph.D., F.C.S. Price, Re. 1-8.

Vol. I, No. V. Construction of Drain Gauges at Pusa by M. H. ARNOTT, M.INST.C.E., with a Preface by J. W. LEATHER, Ph.D., F.C.S. Price, Rs. 3.

Vol. I, No VI. The Loss of Water from Soil during Dry Weather by J. WALTER LEATHER, Ph.D., F.I.C., F.C.S. Price, Rs. 2.

ENTOMOLOGICAL SERIES.

Vol. I, No. I. The Bombay Locust by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2-8.

Vol. I, No. II. The more Important Insects injurious to Indian Agriculture by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 3.

Vol. I, No. III. The Indian Surface Caterpillars of the Genus Agrotis by H. M. LEFROY, M.A., F.E.S., F.Z.S., and C. C. GHOSH, B.A. Price, Re. 1-8.

Vol. I, No. IV. Individual and Seasonal Variations in Helopeltis Theivora, Waterhouse, with description of a new species of Helopeltis by HAROLD H. MANN, D.Sc. Price, Re. 1-8.

Vol. I, No. V. The Coccidae attacking the Tea Plant in India and Ceylon by E. E. Green, F.E.S., and HAROLD H. MANN, D.Sc. Price, Re. 1.

Vol. I, No. VI. The Mustard Sawfly (*Athalia proxima*, Klug) by H. M. LEFROY, M.A., F.E.S., F.Z.S., and C. C. GHOSH, B.A. Price, Re. 1.

Vol. II, No. I. The Rice Bug by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1.

Vol. II, No. II. Remarks on Indian Scale Insects (Coccidae) by E. E. GREEN, F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. III. The Red Cotton Bug by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1.

Vol. II, No. IV. The Castor Semi-Looper by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Rs. 2.

Vol. II, No. V. The Tobacco Caterpillar by H. M. LEFROY, M.A., F.E.S., F.Z.S. Price, Re. 1-8.

Vol. II, No. VI. The Cotton Leaf-Roller by H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S. (*In the press.*)

CALCUTTA:

PRINTED BY THACKER, SPINK AND CO.